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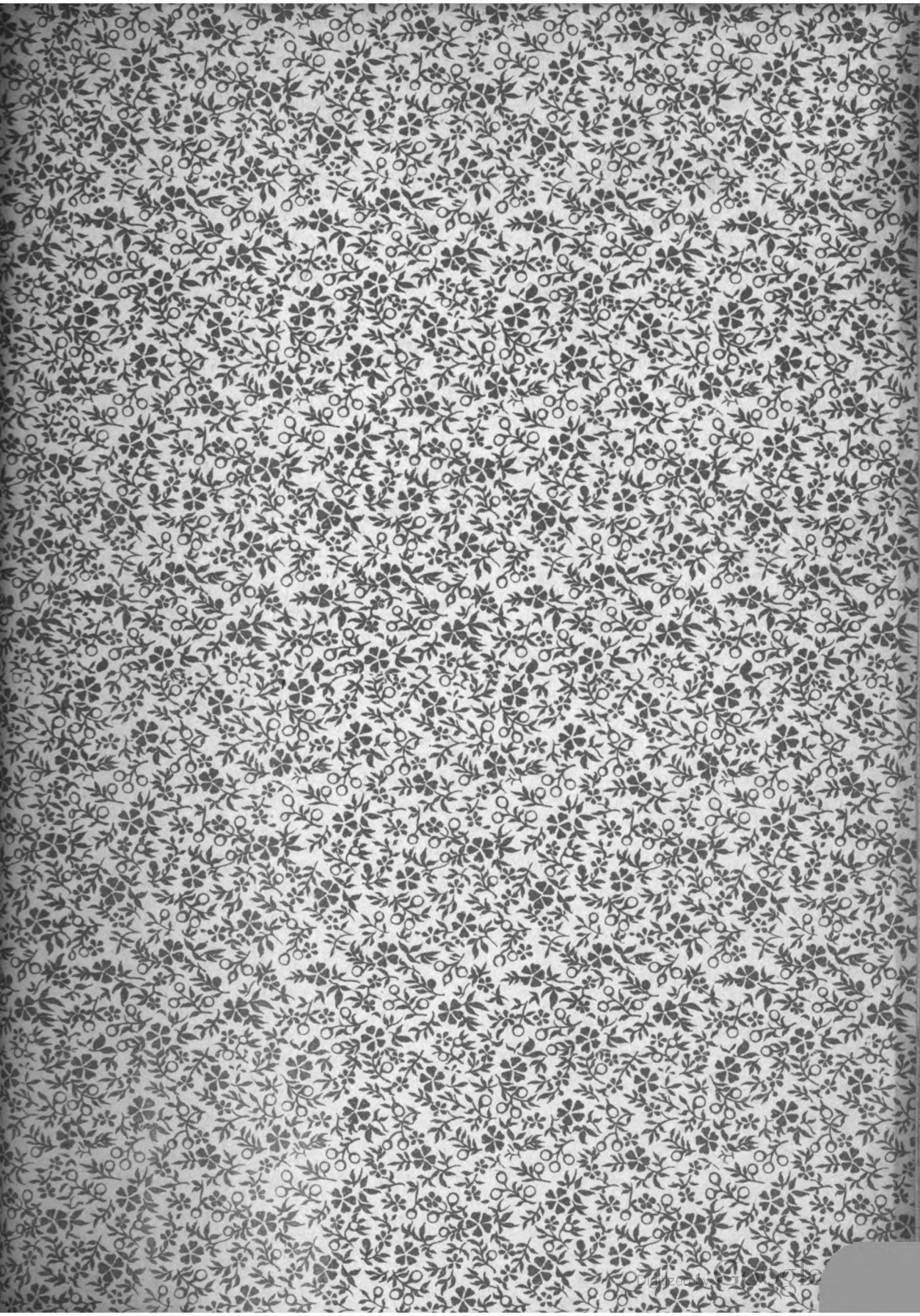
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EDITOR
JOHN LEWIS BREMER
Harvard Medical School

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PROCEEDINGS OF THE AMERICAN ASSOCIATION
OF ANATOMISTS
THIRTY-EIGHTH SESSION

*Osborn Zoological Laboratory, Yale University, New Haven,
Connecticut, December 28, 29, and 30, 1921*

WEDNESDAY, DECEMBER 28, 9.30 A.M.

The Thirty-eighth Session of the American Association of Anatomists was called to order by President CHARLES F. W. McCLURE, who appointed the following committees:

Committee on Nominations for 1922: Professor Alexander S. Begg, Chairman, and Professors H. B. Ferris and C. H. Danforth.

Auditing Committee: Professor Richard E. Scammon, Chairman, and Professor Davenport Hooker.

The remaining morning session was devoted to the presentation of scientific papers.

THURSDAY, 11:30 A.M. ASSOCIATION BUSINESS MEETING, Vice-President T. WINGATE TODD presiding.

The Secretary reported that the minutes of the Thirty-seventh Session were printed in full in *The Anatomical Record*, volume 21, number 1, pages 35 to 41. On motion, seconded and carried, the minutes of the Thirty-seventh Session were approved by the Association as printed in *The Anatomical Record*.

Professor R. E. Scammon reported for the Auditing Committee as follows: The undersigned Auditing Committee has examined the accounts of Doctor Charles R. Stockard, Secretary-Treasurer of the Association of Anatomists, and finds the same to be correct with proper vouchers for expenditures and bank balance on December 20, 1921, of \$172.86.

[Signed] R. E. SCAMMON,
DAVENPORT HOOKER.

The Treasurer made the following report for the year 1921:

Balance on hand December 29, 1920, when accounts were last audited.....	\$164.40
Receipts from dues 1921.....	2,881.86
	<hr/>
Total deposits.....	\$3,046.26
Expenditures for 1921:	
Expenses Secretary-Treasurer, Philadelphia Meeting.....	\$19.10
Postage and telegrams.....	50.46
Printing and stationery.....	86.74
Collection and exchange on drafts.....	4.10
Stenography, typewriting.....	49.50
Paid bank for credit North Dakota check.....	7.00
Member Second International Eugenics Congress.....	5.00
Wistar Institute, subscriptions to Journal of Anatomy, Anatomical Record, etc.....	2,651.50
	<hr/>
Total expenditures.....	2,873.40
	<hr/>
Balance on hand.....	\$172.86
Balance on hand deposited in the name of the American Association of Anatomists in the Corn Exchange Bank, New York City.	

On motion, the report of the Auditing Committee and the Treasurer were accepted and adopted.

The Committee on Nominations, through its Chairman, Professor Ross G. Harrison, placed before the Association the following nominations for office in the Association: For President, Clarence M. Jackson; for Vice-President, Harold D. Senior; for Secretary-Treasurer, Lewis H. Weed; for members of Executive Committee, terms expiring 1925, Davenport Hooker and Benjamin F. Kingsbury.

On motion, the Secretary was instructed to cast a ballot for the election of the above named.

The Secretary then announced that the election of Lewis H. Weed as Secretary-Treasurer caused a vacancy on the Executive Committee for a two-year term. The President then called for a nomination to fill this vacancy.

Professor Irving Hardesty was nominated and elected to serve on the Executive Committee until 1923.

The Secretary presented the following names recommended by the Executive Committee for election to membership in the American Association of Anatomists:

- ADAMS, L. A., Ph.D., Instructor in Comparative Anatomy, *University of Illinois, Urbana, Ill.*
- BAST, T. H., B.A., Ph.D., Assistant Professor of Anatomy, *University of Wisconsin, Madison, Wis.*
- CAMERON, ANGUS L., M.D., Ph.D., Assistant Professor of Surgery, *Medical School, University of Minnesota, Minneapolis, Minn.*
- CALKINS, LEROY A., M.D., Ph.D., Assistant Professor of Obstetrics, *Medical School, University of Minnesota, Minneapolis, Minn.*
- DUNN, H. L., M.A., *Department of Anatomy, University of Minnesota, Minneapolis, Minn.*
- GATENBY, J. BRONTE, Ph.D., Professor of Zoology, *Trinity College, Dublin, Ireland.*
- GEIST, FREDERICK D., M.D., Instructor in Anatomy, *University of Wisconsin, Madison, Wis.*
- GREEN, R. B., M.B., F.R.C.S., Demonstrator of Anatomy, *University College, Gower St., London, W. C. 1, England.*
- HANSON, FRANK BLAIR, Ph.D., Associate Professor of Zoology, *Washington University, St. Louis, Mo.*
- HARWELL, CHAS. S., A.B., M.D., Assistant Professor of Anatomy, *Emory University, 435 Euclid Ave., Atlanta, Ga.*
- HUNTER, JNO., M.B., Ch.M., Anatomy Department, *Sydney University, Sydney, Australia.*
- HUBER, ERNST, Ph.D., Associate in Anatomy, *Johns Hopkins Medical School, Baltimore, Md.*
- HOY, WM. E., JR., Ph.D., Professor of Biology, *Presbyterian College of S. Carolina, Clinton, S. C.*
- HUMPHREY, RUFUS R., A.M., Instructor in Histology and Embryology, *Cornell University, Ithaca, N. Y.*
- LEE, FERDINAND CHRISTIAN, A.B., M.D., Instructor in Anatomy, *Johns Hopkins Medical School, Baltimore, Md.*
- MILLER, SHIRLEY P., A.B., A.M., Instructor in Anatomy, *Anatomical Institute, University of Minnesota, Minneapolis, Minn.*
- MULL, PHILIP L., B.S., M.D., Instructor in Anatomy, *University of Louisville, Medical Department, Louisville, Ky.*
- NITTONO, K., M.D., Professor of Anatomy, *Chiba Medical College, Chiba, Japan.*
- NICHOLSON, F. M., Ph.D., Assistant in Pathology and Bacteriology, *Rockefeller Institute for Medical Research, 68th Street and Avenue A, New York.*
- ROMER, ALFRED S., B.A., Ph.D., Instructor in Anatomy, *University and Bellevue Hospital, Medical College, 338 East 26th St., New York City.*
- RIENHOFF, WILLIAM F., JR., A.B., M.D., Instructor in Surgery, *Johns Hopkins Hospital, Baltimore, Md.*
- SMITH, BERTRAM GARNER, A.B., Ph.D., Associate Professor of Anatomy, *University and Bellevue Hospital Medical College, 338 East 26th Street, New York City.*

- SMITH, CHRISTIANNA, A.M., Instructor in Zoology, *Mt. Holyoke College, South Hadley, Mass.*
- STARK, MARY, Ph.D., Professor of Histology and Embryology, *New York Homeopathic College, New York City.*
- STEVENSON, PAUL H., M.D., Assistant in Anatomy, *Peking Union Medical College, Peking, China.*
- SISSON, SEPTIMUS, B.S., V.S., Professor of Veterinary Anatomy, *Ohio State University, Columbus, Ohio.*
- SYKES, GEO. F., Ph.B., M.A., Professor of Zoology and Physiology, *Oregon State Agricultural College, Corvallis, Oregon.*
- UHLENHUTH, EDUARD, Ph.D., Associate in Pathology, *Rockefeller Institute for Medical Research, 66th Street and Avenue A, New York City.*
- WHITESIDE, BEATRICE, Ph.D., Instructor in Anatomy, *Washington University Medical School, St. Louis, Mo.*
- WOODMAN, A. S., M.D., Assistant Professor of Histology and Embryology, *Boston University School of Medicine, Boston, Mass.*

On motion, the Secretary was instructed to cast a ballot for all the candidates proposed by the Executive Committee. Carried.

The Secretary then announced the following names as dropped from the list of members on account of non-payment of dues for the past two years:

- DR. E. A. BAUMGARTNER, Halstead, Kansas.
- DR. W. B. CHAPMAN, Washington University, St. Louis, Mo.
- DR. ELBERT CLARK, University of Chicago, Chicago, Ill.
- DR. FABIO FRASSETTO, University of Bologna, Italy.
- CAPT. C. F. SILVESTER, Army Medical Museum, Washington, D. C.

It was announced that the Executive Committee had voted to hold the next annual meeting during Easter week of 1923 in the central part of the country, or Mississippi Valley, the place to be determined later.

The Executive Committee nominated four persons, two of whom were to be elected by the Association for membership on the Journal Committee as organized at the previous meeting. As a result of the election, Professor F. T. Lewis was chosen to serve for five years and Professor H. M. Evans to serve for four years as members of this committee.

It was moved by Professor H. H. Donaldson and seconded, That the Association express to the retiring Secretary-Treasurer its sincere appreciation of his efforts for, and loyalty to, the

Association during his years of service. The motion was approved by a rising vote.

On motion, the business session then adjourned.

FRIDAY, DECEMBER 30. A BUSINESS SESSION followed the morning Scientific Session.

A discussion regarding the publication in the Proceedings of the Meeting of abstracts by persons not attending the sessions was introduced. It was finally resolved that in the future those members not intending to be present at the meeting should send in their communications as to be read by title only. The abstracts of such communications are to be published in connection with the proceedings of the meeting.

Professor G. L. Streeter introduced the following resolution:

RESOLVED: That the Association express to the authorities of Yale University its sincere appreciation of the exceptional facilities and accommodations that have been provided for this meeting, and which have in so large part contributed to its success, and also for the cordial hospitality of Professor Harrison, Professor Ferris, and the members of the local committee that has been so generously extended to all those in attendance.

Unanimously voted.

On motion, the Session adjourned.

CHARLES R. STOCKARD.

Secretary of the Thirty-eighth Session of the
American Association of Anatomists.

ABSTRACTS

1. *A comparison of the cerebellar tracts in three teleosts.* WILLIAM H. F. ADDISON, University of Pennsylvania.

The cerebellar fiber-tracts of three fishes of different habits have been studied, in order to compare the relative sizes attained by each tract in the three species. The three fishes were *Gadus morrhua* (cod), *Arius* (a small Siluroid), and *Pleuronectes limanda* (flounder). Serial sections were studied in the Netherlands Central Brain Institute of Amsterdam, by courtesy of Dr. Ariens Kappers, director. The afferent cerebellar tracts in the teleostean brain are: mesencephalo-cerebellaris anterior, mesencephalo-cerebellaris posterior, lobo-cerebellaris, spino- et olivo-cerebellaris, vestibulo-cerebellaris, and laterali-cerebellaris. The efferent cerebellar tract is the cerebello-motorius, of which the most anterior part is the brachium conjunctivum anterius. Two examples illustrating the nature of the study may be given. The mesencephalo-cerebellaris anterior is largest in cod, intermediate in flounder, smallest in *Arius*. This tract arises in part from the tectum opticum, transmits impulses from the visual centers, and is largest in the form having the largest visual apparatus. The mesencephalo-cerebellaris posterior is largest in *Arius* and less well-developed in the other two. This tract arises near the end-station of the lateral lemniscus, probably transmits impulses from the latter, and is largest in the form having the best-developed lateral-line organs. In this way, one may correlate in size the various afferent tracts with the receptors from which they transmit impulses to the cerebellum, and may gain evidence as to the relative part played by the different tracts in the formation of the cerebellum.

2. *Growth of the medullary tube grafted into the allantois.* (Lantern.) ANNA AGASSIZ and VERA DANCHAKOFF, Columbia University.

The development of the spinal cord manifests a high degree of independence from its continuity with the cranial part of the central nervous system. A number of grafts of blastoderms were made at different stages, beginning with 5 somites. The part of the blastoderm which contained the four or five, sometimes a greater number of cranial somites was severed and the caudal part, containing 1 to 10 somites, grafted into the allantois. That part of the neural tube which had been closed at the time of grafting invariably grows and differentiates in a manner similar to that in which it does normally. It is more difficult at present to conclude whether the ectoderm caudally to the somites will as readily differentiate. Not only does the neural tube differentiate white and grey matter in the graft, but, as demonstrations will show, the grey matter differentiates into ventral and dorsal horns, and even various cell groups in these can be recognized. Interesting data in relation to the migration of groups of nerve cells are obtained, inasmuch as groups of nerve cells are found scattered in the graft through regions of more or less undifferentiated tissue. Nerve trunks grow without reaching the organs they would normally have supplied, as these organs

often fail to develop. Neither continuity with the cephalic part for the differentiation of the spinal cord, nor presence of developing organs for migration of nervous ganglia and growth of nerve trunks seems to be required for growth and development of the nervous tissue in the embryo.

3. *The morphogenesis of the hypophysis in the tailed amphibia.* WAYNE J. ATWELL, Medical Department, University of Buffalo.

The hypophysis has been studied in *Ambystoma*, *Spelerpes*, *Necturus* and *Amphiuma*. The most striking difference between these forms and the *Anura* previously studied is in regard to the adult condition of the *pars tuberalis*. As in the *Anura* this part has its origin from a pair of processes which grow forward from the remainder of the gland. These processes do not become detached to form separate epithelial plaques as they do in the frog and the toad at the time of metamorphosis, but maintain their connection with the anterior lobe throughout life. The anterior lobe proper and the *pars intermedia* develop as in the *Anura* except that the adult position of the *pars intermedia* is dorsal to the anterior lobe rather than caudal to it. The neural lobe is considerably sacculated in *Necturus* and *Ambystoma*. Judging from this criterion alone, these two forms are primitive and are rather closely related to certain of the fishes.

4. *Autoplastic transplants of the epithelial hypophysis in larvae of *Rana pipiens*.* WAYNE J. ATWELL, Medical Department, University of Buffalo.

The epithelial hypophysis was transplanted from the head to the tail in very young tadpoles of *Rana pipiens*. The operated animals failed to develop the typical silvery appearance of the hypophysectomized tadpole. They were, however, lighter in color than normal larvae. Examination of the living tadpole under the binocular microscope shows that the melanophores are not so contracted nor the xantholeucophores so widely expanded as in the typical silvery larva. The appearance is that the hypophysis, or at least the *pars intermedia*—which is responsible for the color change—has been only partly compensated for by the transplant. The condition is evidently that of a chronic hypophyseal insufficiency. Serial sections show that the hypophysis was completely removed from the head. The region of the transplant in the tail is readily observable macroscopically because of the expanded condition of the melanophores in the immediate vicinity. This probably indicates a local effect of the transplanted gland. Although the transplant was apparently functioning more than four months after the operation none of the tadpoles underwent metamorphosis. Whether this is due to the atrophy of the anterior lobe tissue in the transplants can not be stated because the degree of histological differentiation is not sufficient to permit identification of the separate parts. It is possible, however, to identify two varieties of cells in the transplant, both apparently parenchymal.

5. *The increased absorption of x-ray energy by vitally stained white rats.* W. M. BALDWIN, Union University (Albany) Medical College.

Paramoecia which are vitally stained indicate an increased susceptibility to the action of x-ray energy. This investigation represents an effort to establish a general principle covering the absorption by living tissues of x-ray energy increased through chemical means. The source of this energy was a large Cool-

idge water-cooled tube carrying a load of 50 Mam. at 50 K.V. The rats were placed 17.5 cm. from the center of the target and each was rayed for two consecutive minutes. A dosage of 100 Mam. minutes was sufficient to induce death at an average of from 100 to 120 hours after the exposure. When such vital stains as trypan blue, trypan red, neutral red, isamine blue, etc., were used in an amount not sufficient to affect the vitality of the rats, a dosage of 100 Mam. minutes induced death within from forty-eight to fifty-six hours. This increase in the absorption of x-ray energy conforms to the results obtained by Hertel studying bacteria sensitized to radiant energy of the length of ultraviolet light rays.

6. The sitting height. *Based on the measurements of more than 225,000 individuals.*

R. BENNETT BEAN, University of Virginia.

Age. Girls are precocious and boys retarded in the growth of the sitting height. The sitting height grows more rapidly at and after puberty than before. It remains stationary from 25 to 60 years and decreases thereafter. The hypophylomorph is retarded and the hyperphylomorph precocious in the growth of the sitting height, and the mesophylomorph is intermediate. The Asiatic has the sitting height accelerated early and retarded late in growth, the growth of the sitting height in the African is late and short, and the European is intermediate. The Asiatic has a long torso and short legs, the African a short torso and long legs, and the European is intermediate, in the adult.

Race and type. We may group the races by type:

Extreme hypophylomorph: Aino, Lapp, Pigmy, Eskimo, Siberian, Aymara.

Hypophylomorph: Southeast Asia. Some negroes and Negritos.

Mesophylomorph: American Indian. Central Asia. Some negroes.

Hyperphylomorph: European, Indo-European, Nordic and derivatives.

Extreme hyperphylomorph: Mediterranean race and related stocks.

Each race has hypo stocks, and some have meso and hyper. The Lapps, Finns, and Ainos are the hypos for Europe, the Alpine and sub-Nordics are the mesos, and the Nordic and Mediterranean are the hypers. The Pigmies are the hypos for Africa, the Central Africans are the mesos and the long-legged Negritos are the hypers. The Siberians and southeast Asiatics are the hypos for Asia, the Chinese are the mesos, and the Thibetans and Japanese are the hypers.

Race movements have altered the type.

7. Contraction rate of the uterine musculature of the rat with reference to the oestrous cycle. EDWARD W. BLAIR (introduced by Herbert M. Evans), Department of Anatomy, University of California.

The spontaneous rhythmical contractions of the excised rat uterus (one horn), suspended in warm (38°C.) oxygenated Locke's solution, were recorded by means of a heart lever writing on a long-roll kymograph. The rhythm is found to be slowest at the time of oestrus, increasing gradually to a maximum late in the resting stage, and decreasing rather suddenly at the pro-oestrus. The contraction and relaxation time are little affected, the difference being in the interval between contractions. The rhythm of the resting uterus is often broken by the appearance of superimposed contractions before relaxation is complete. These were ignored in estimating the rate. Barely perceptible minimal contractions are often interpolated between the ordinary maximal contractions of the uterus,

at and near oestrus. These also are ignored in the data tabulated. Age and history of previous pregnancies also influence the rhythm, but do not affect the influence of the oestrous cycle.

SMEAR	NUMBER OF ANIMALS OBSERVED	MEAN INTERVAL BETWEEN CONTRACTIONS	RATE PER HOUR
		minutes	
Small epithelial cells only (Pro-oestrus).....	2	2.34	25.6
Small epithelial and cornified cells (Oestrus).....	5	2.5	24.0
Cornified cells only (Post-oestrus).....	4	1.42	42.3
Leucocytes and epithelial cells (Early Di-oestrous interval).....	5	1.06	56.6
Leucocytes and epithelial cells (Late Di-oestrous interval).....	2	0.77	77.9

8. *The pancreatic ducts of the white rat.* J. L. BREMER, Harvard Medical School.

The pancreas of the white rat surrounds the hepatic duct throughout almost the entire extent of the latter from liver to duodenum, and is connected with it by numerous ducts. These all represent ventral pancreas, as the duct of the dorsal pancreas degenerates early. The original relations of liver diverticulum, single ventral, and dorsal pancreas are similar to those in other mammals. Besides these true pancreatic ducts, of varying size, many smaller blind gland-like pockets open into the hepatic duct.

9. *The control of head formation in Planaria dorotocephala by means of anesthetics.*

J. W. BUCHANAN (introduced by R. G. Harrison), Yale University.

By mass experiments it is shown that head frequency in pieces of *Planaria* can be controlled by subjecting the pieces for short periods after section to appropriate concentrations of chloretone, chloroform, chloral hydrate, ether, and ethyl alcohol; that in such concentration of these agents the increase of oxygen consumption following section does not occur.

The evidence shows that the factors controlling head formation are non-specific and supports Child's conclusions regarding the nature of these factors, viz., that head formation is determined by the relative activities of two antagonistic factors: 1) the tendency of the cells near the anterior cut surface of the piece to de-differentiate and to develop into the head of a new individual; 2) the tendency of the whole of the piece, exclusive of the cells concerned in the development of the new head, to maintain the differentiation of the old individual, exerting a certain degree of control over the cells near the anterior cut surface and tending to prevent the development of a new head.

The facts indicate that anesthetics alter head frequency, 1) by direct inhibition of the processes of development of the cells concerned in the formation of the new head, causing decreases in head frequency; 2) by inhibition of the increase of metabolic activity of the whole of the piece following section; in pieces from

certain regions this effect overbalances the direct effect on the developmental processes of the cells concerned in forming the new head and in such pieces head frequency is increased.

10. *The fate of the neuropore in Amblystoma embryos.* H. S. BURR, The School of Medicine, Yale University.

A study during the past few years of the early stages in morphogenesis of the cerebral hemispheres in *Amblystoma* has confirmed the findings of Kingsbury ('20) concerning the rostral relations of the primary columns of His, and indicated the possibility of an experimental solution to the question of the fate of the neuropore. Small wounds made in the ventral lip of the neuropore and stained with Nile blue sulphate could be followed for many days during subsequent development. By comparing careful camera lucida drawings of such operated embryos, with median sagittal sections of the same it was possible to locate with precision the ultimate position occupied by the lips of the neuropore. The ventral lip of the neuropore is incorporated into the neural tube as the terminal ridge (Johnson '09). The lateral lips of the neuropore fuse to form the lamina terminalis. It is evident, therefore, that the lamina terminalis is the terminal portion of the roof plate of His which by this fact ends at the terminal ridge. Furthermore, the alar plates forming as they do the lateral boundaries of the roof plate sweep, in the terminal ridge, across the mid line thus bringing the alar plate of one side into direct continuity with that of the opposite side. This means that the mid ventral region of the rostral end of the neural tube is, in *Amblystoma*, occupied by the alar plate as far caudad as the preoptic recess and not by the floor plate.

From this latter point, the terminus of the sulcus limitans, the mid ventral line of the neural tube as far caudad as the fovea isthmi shows in *Amblystoma* none of the characteristics of floor plate material. Rather as Kingsbury ('20) has shown in other forms, this region is occupied in the main by nervous tissue which is continuous, in the early stages with the basal plate of the neural tube.

We find in *Amblystoma*, then, that the rostral relations of the primary columns of His are as follows: The roof plate terminates at the terminal ridge and the floor plate at the fovea isthmi. The alar plates are continuous from side to side in the terminal ridge, and the basal plates in the region from the fovea isthmi to the preoptic recess show a similar continuity.

11. *The development of the nasolacrimal apparatus in Amblystoma.* H. S. BURR and E. S. A. ROBINSON, The School of Medicine, Yale University.

An experimental study of the development of the nasolacrimal apparatus in *Amblystoma* has revealed the following facts. The entire canal, including the superior and inferior lacrimal ducts, is laid down as a thickening of the inner layer of the ectoderm along the bottom of the naso-optic furrow. By proliferation and delamination the thickening develops into a solid cord of cells which begins to separate from the ectoderm at the nasal end. This separation is never entirely completed as the ocular end retains its connection through subsequent growth. Eventually the nasal end of the cord sinks through the mesenchyme of the head to become attached to the nasal epithelium. Lumen formation starts in the solid cord usually at the ocular end by tangential mitoses of the peripheral cells and migration of the central cells into the interstices between the former.

Operations involving the removal of the eye in one series, of the nose in a second, yielded the following results. In each type of operation the removal of the sense organ involved also the removal of the primordium of the lacrymal apparatus since the eye and the nose at this stage of operation are so closely related that the ectodermal site of the apparatus is usually removed when either is extirpated. The absence of either the ocular or the nasal placode associated with removal of the naso-optic furrow results in the absence of these passages, hence neither sense organ is a determining factor in regeneration of the nasolacrymal apparatus. Incomplete removal of the optic-furrow results in partial regeneration of the passages irrespective of the presence or absence of the sense organs.

12. *The topography of the abdominal viscera in the late embryonic and the fetal period of man as determined by graphic reconstruction.* (Lantern.) ANGUS L. CAMERON (introduced by R. E. Scammon), Department of Anatomy and Department of Surgery, University of Minnesota.

The topography of the abdominal viscera of fifty selected specimens of the latter part of the embryonic and of the fetal period was determined by means of graphic reconstructions with the orthoscopic apparatus and by field graphs of the vertebral levels of the various portions of the abdominal organs.

The transition from the embryonic to the fetal period is characterized by a number of marked changes in abdominal topography. These are completed, in the main, by the close of the third month, and during the rest of the fetal period the relations of the viscera to skeleton and to each other remain remarkably constant. The chief changes in abdominal topography in the fetal period are those of the caecum, splenic flexure and sigmoid flexure. The axis of the spleen is also somewhat modified and the head of the pancreas is depressed.

These results fall in line with the findings of other workers in this laboratory that the growth of the external proportions of the abdomen follows a constant course in the fetal period. The particular changes enumerated above seem to be principally mechanical ones dependent on the distension of the colon with meconium in the latter months of prenatal life.

13. *Studies in the dynamics of histogenesis. VII. The experimental transformation of the smooth bladder muscle of the dog, histologically into cross-striated muscle and physiologically into an organ manifesting rhythmicity.* E. J. CAREY, Marquette School of Medicine.

1. The essential difference between the pale smooth muscle of the bladder and the red involuntary striated muscle of the heart is finally dependent upon the differential intensity of hydrodynamic tensional stimuli (work) to which the vesicular and cardiac mesenchymal cells are subjected, respectively. If the growing vesicular smooth muscle is subjected to a stimulus comparable to that found in the heart, will cross-striated muscle be differentiated? The answer is yes.

2. The evidence presented proves definitely that the pale bladder musculature may be transformed into the red, cross-striated type by increasing the tensional stimulus to a degree comparable with that which the cardiac mesenchyme experiences normally.

3. Muscle tissue is not a self-differentiated product, but is a biomechanical resultant of an optimum tension. The variable intensity of the optimum tension determines the muscular type. The growing cells receive and respond to the mechanical tensional stimulus. The stimulus, however, is a function of position.

4. The evidence herein presented proves that the structure of striated muscle is determined by the function it performs and the work it does and that cross-striated muscle is not formed in anticipation to a future function. The conclusion is warranted that function in this case determines structure, and not the reverse.

14. *Transformations of the branchial arteries in man.* E. D. CONGDON, Stanford University Medical School.

Owing to the subtlety of the changes in the walls of the branchial arteries, there are very few portions of the carotids or of the definitive aortic arch that can with certainty be allotted to specific parts of the branchial system. This is illustrated by the changes taking place after the disappearance of the first and second branchial arteries, when the third, fourth, and sixth radiate upward from a pouch and the primitive external carotid comes off at the junction of the third artery and the pouch. The region of union of the third and fourth branchial arteries and the external carotid is seen to migrate upward. This is apparently due in part to the remodeling of the pouch wall into a tube. Perhaps there is also a blending of the lower ends of the two branchial vessels. By a similar process the point of union of the primitive external carotid with the third branchial artery is in turn carried away from the fourth by the formation of an intermediate trunk, the common carotid.

15. *The reticular material as an indicator of physiologic reversal in secretory polarity in the thyroid cells of the guinea-pig.* E. V. COWDRY, Rockefeller Institute for Medical Research, New York.

In the thyroid glands of normal guinea-pigs, the reticular material (i.e., Golgi apparatus, canalicular apparatus, etc.) is not invariably found between the nuclei and the follicular lumen, as is generally supposed; but in some cases undergoes an active migration to the opposite pole of the cell, which, together with other evidence at hand, indicates the existence of a reversal in physiologic polarity whereby the secretion is discharged directly into the circulation, instead of being first stored within the follicles.

16. *Studies on the spleen.* R. S. CUNNINGHAM. Department of Anatomy, Johns Hopkins Medical School.

a. *The rôle of the spleen in experimental hydremia.* In two series of experiments on cats hydremic plethora was produced by continued intravenous injection of physiological saline. In normal animals about 40 cc. of fluid collected in the peritoneal cavity before there was any in the pleural or pericardial cavities. In animals whose spleens had been previously removed fluid appeared simultaneously in all three cavities. It was also found that a considerably larger amount of fluid must be injected in splenectomised animals in order to obtain an ascites equal to that produced in normal animals. In contrast to the other abdominal organs the spleen apparently never became edematous even in those

experiments in which large amounts of fluid were injected. The mesothelial cells of the spleen, from animals in which an ascites was developing, were found to contain vacuoles of various sizes. In certain experiments in which iron ammonium citrate and sodium ferrocyanide were injected intravenously granules of Prussian blue were found in these vacuoles. *b. Reaction of the splenic mesothelium to vital dyes.* In animals that had been vitally stained by intravenous injections the splenic mesothelial cells contained the dye in fine perinuclear granules. After irritation the cells became cuboidal and finally columnar, and the granules of vital dye were collected principally in the infranuclear zone of the cell. This location of the vital dye inclusions was very similar to, but considerably less in amount than, that found in the germinal epithelium of the ovary.

17. *Grafts in the allantois of embryonic anlagen of the chick.* (Lantern.) VERA DANCHEAKOFF, Columbia University.

Young blastoderms in toto, parts of blastoderms at various stages and chick anlagen of different organs, were grafted into the allantois. The earlier a whole blastoderm is transferred to the allantois, the less growth and differentiation is obtained. It seems as if energetic growth of embryonic cell groups can be effected in the allantois only after a definite organization of the embryonic cell material has been completed. Such organization fails to take place in the allantois, if the blastoderm is transferred into it at a stage of early primitive streak, and the growth resulting from such a graft contains only islands of undifferentiated tissue. If, however, the blastoderm is allowed to develop to an advanced primitive streak stage showing a slight indication of the head process and is then grafted the different cell groups grow well and reach a high degree of differentiation.

Among such cell groups it is especially those which develop into kidney, nervous tissue, eye and notochord, which seem to manifest the least disturbing effect from the transfer of the blastoderm into the allantois. The segment stalks develop tubules and Malpighian glomerules, the neural plate differentiates gray and white matter, sends out nerve trunks, and groups of nerve cells migrate far away into various parts of the graft, the visual organ develops pigment and lens; the notochord attains a considerable size and becomes surrounded by cartilage; a cartilaginous envelope is formed around the spinal cord and in this different parts of normal vertebra are recognized.

Separated parts of the blastoderm also grow on the allantois. A curious result was obtained in relation to the pronephros. Blastoderms with 10 and more somite embryos were cut into two parts, between the 8th and 9th somite, and the cranial part with the anterior 7-8 somites grafted. In this case the pronephros seems to attain a more extensive development than that reached by the pronephric anlage under normal conditions.

18. *The question of digital homology.* C. H. DANFORTH, Washington University School of Medicine.

The character of a digit appears to be regulated by at least two different factors. One is the tendency of limb-buds to produce terminal lobulations, the other is something in the general nature of gradients between the pre- and post-axial borders. The 'gradients' of the upper and lower limbs are apparently equivalent, but the lobulations do not seem to be so. When the hand and foot are

compared it becomes apparent that, if the digits of the two limbs are considered as equivalent units, many comparable features are nearer the preaxial side of the foot than of the hand. Thus, in the hand the longest digit is the third; in the foot, usually the second. Hair centers for the mid-digital segments are on the fourth finger and the third toe. The Mm. interossei are oriented with reference to the third finger and the second toe. Other muscles and bones show similar tendencies, although less clearly. Simple hereditary syndactyly involves the third and fourth fingers, the second and third toes. Accessory tendons from the preaxial side reach the second finger oftener than they reach the second toe. Tendons to the fifth toe are suppressed more frequently than those to the fifth finger. These facts, with the strongly corroborative evidence from polydactyly, are interpreted to mean that the digits of the hand are not serially homologous with those of the foot, the great toe being equivalent to rather more than the thumb, the little toe to somewhat less than the little finger.

19. *Some significant features of the anatomy of a symelian monster (Symplus monopus).* ALDEN B. DAWSON, Loyola University School of Medicine, Chicago.

Ballantyne ('04) has shown that fetuses which have only one umbilical artery almost constantly present the malformation known as symphodia. He believed that the single artery of the cord was vitelline in origin and accordingly concluded that the arterial supply of the placenta must be non-allantoic. In the case under discussion, however, the single umbilical artery appeared to be formed by the fusion of two umbilical arteries. The single trunk took its origin from the aorta a short distance below the superior mesenteric, the inferior mesenteric appearing as a branch of the umbilical. The relatively high origin of the umbilical artery can be explained as a retention of the early embryonic position. Caudally the umbilical trunk gave off a single iliac trunk which divided to supply the fused lower limbs.

There were no genito-urinary or anal apertures. Both testes were present, but the right was undescended. Their vasa deferentia opened into the blind end of the digestive tract. The right kidney was absent. The left was rudimentary, and its ureter opened into the left vas. Both suprarenal glands were present and their arterial supply was of the embryonic type.

The caudal end of the vertebral column was suppressed and the spinal cord extended the entire length of the canal, i.e., to the level of the fourth sacral vertebra. The segmentation of the thoracic region was disturbed. Extensive fusion occurred in the pelvic girdle. There was a single median femur, a single median fibula and two lateral tibiae.

The anomalies which are constant for this group of monsters will be described in detail, and their developmental significance discussed.

20. *The standardization by empirical formulae of the data on surface area in man and animals.* H. L. DUNN (introduced by R. E. Scammon), Department of Anatomy, University of Minnesota.

This study is limited to a consideration of the recorded data on the surface area of man and animals. The material obtained was analyzed graphically and its expression developed by the use of empirical formulae.

The animals in which the relation of body weight to surface area has been determined are cattle, guinea-pigs, rats, rabbits, frogs and lizards. However, the data on these forms are not sufficient to permit a comparison with human material. In man the relationship of surface area to body weight, body length and time in years has been studied by four classes of methods: a) the paper and mould methods which are the most accurate since they closely approximate the surface; b) the geometric method, which is only of approximate accuracy; c) the linear method of DuBois based on empirical measurements; d) the photographic method of Benedict which involves the application of DuBois' linear formula to photographic silhouettes.

Conclusions: 1) The results of the paper and mould methods must be regarded as the most reliable. 2) The curve of the central tendency of all data on the relation of surface area to body weight in man may be expressed by the general empirical formula: $Y = 0.02 X^2 + 3.9 X + 10$ in which Y is square decimeters, X kilograms, and 10 is an empirically determined constant.

§1. The azurophile granulation of the lymphoid cells of the blood during digestion and fasting and in relation to the tributaries of the venous system. V. E. EMMEL, Department of Anatomy, University of California.

A quantitative study of the azurophile granulation in the lymphoid cells of the circulating blood of the rat was made with reference to digestion and fasting, together with a comparative analysis of the blood in the tributaries of the venous system with the following results:

First. That in any given animal under constant physiological and dietary conditions the percentage of lymphoid cells showing azurophilic granulation, as tested for the peripheral circulation from day to day, is relatively constant. Second. In animals fasting for 24 to 90 hours there is a decrease in the percentage of azurophile granulation followed by a pronounced increase during digestion. Third. In animals under normal physiological conditions the inferior cava, superior to the hepatic veins, constantly gave a higher percentage of azurophile granulation as compared with the superior cava. Fourth. Upon analysis of the tributaries of the inferior cava, the portal vein was found constantly higher in the percentage of azurophile granulation than that of the abdominal part of the inferior cava; the latter being practically equal to that of the peripheral circulation. Fifth. On the other hand, in fasting animals this difference, with respect to the portal vein, largely disappeared, so that the azurophile granulation for the portal vein was now essentially the same as that of both the peripheral circulation and the inferior cava inferior to the hepatic veins. Sixth. The above differences based upon the percentage of the total number of lymphoid cells containing azurophile granulation is further confirmed and emphasized by corresponding differences in the numerical content of azurophile granules within these cells.

A further analysis of the tributaries of the portal system, together with the effect of different diets, is under investigation.

22. The percentage of polychromasia in the blood of the rat as correlated with gestation, lactation, and the oestrous cycle. V. E. EMMEL and J. E. WALKER, Department of Anatomy, University of California.

In a number of mammals a certain percentage of the erythrocytes in the circulating blood, normally show a polychromatophilic reaction to basic dyes. As this polychromasia is especially pronounced in the rat, it has been utilized as an index in determining to what extent there may be an interaction between the activities of the reproductive system and the cellular elements of the blood in this animal. The present stage of this investigation shows the following results:

A. Successive blood tests for any given normal male or non-pregnant female gave a relatively constant percentage of polychromasia. B. In female rats, during gestation, there was a definite rise in the percentage of polychromasia. This increase was further accentuated during lactation. In both instances, this increase appeared most pronounced in the earlier phases of these stages. C. Fluctuations in the total erythrocyte count seemed, in general, to correspond with these changes in the percentage of polychromasia. D. A control series of non-pregnant animals failed to show changes corresponding to the pregnant and lactating animals. E. In tests made during the oestrous cycle the percentage of polychromasia was always slightly higher at the pro-oestrous stage and correspondingly lower at the following di-oestrous stage. F. In a series of observations on postnatal changes in the blood of three males the percentage of polychromasia gradually declined from an average of 21.3% at birth to 5.1% on the 56th day. This is suggestive of a correlation between the postnatal reduction in polychromasia with the attainment of sexual maturity—a conclusion which remains to be confirmed by further investigation.

23. On an invariable and characteristic disturbance of reproductive function in animals reared on a diet poor in fat soluble vitamins A. HERBERT M. EVANS and KATHERINE SCOTT BISHOP, Department of Anatomy, University of California.

Studies herein reported confirm the impression that rats may be successfully reared on diets poor in vitamin A if the diet is not too deficient in this essential. They may for months grow normally and not suffer from the so-called xerophthalmia. It must be admitted that we have not had previously a method for the detection of deficiencies in this vitamin which, nevertheless, permit good growth and apparent health. Studies on the oestrous cycles of such rats show them to suffer from an invariable and continuous abnormality or disfunction of the ovaries.

It has previously been shown in this laboratory that ovulation in the rat can be detected in the living animal by a series of histological changes in the vaginal smear, changes which are correlated with the growth, maturation and rupture of the graafian follicles at periodic intervals. When for any reason the follicles are unable to completely mature (as in animals treated with hypophyseal substance) the vaginal oestrous changes are absent. If follicles develop but are unable to rupture, the oestrous changes may be remarkably prolonged, and the dioestrous pause, in fact, obliterated. As Evans and Long have shown, this occurs as a rare anomaly in large colonies of animals. But this prolongation of oestrous vaginal changes and failure of ovulation occurs in 100 per cent of animals

reared on diets which are low in vitamine A but which nevertheless permit normal growth. We have used typical diets employed by E. V. McCollum and by T. B. Osborn and L. B. Mendel, in which the chief fat content was furnished by lard. On the administration of small quantities of dried, powdered leaves of young succulent alfalfa or of small quantities of butter fat, this characteristic abnormality in oestrus and ovulation was cured.

24. Oestrus and ovulation in the rat, from a large group of animals on a standard diet. HERBERT M. EVANS and KATHERINE SCOTT BISHOP, Department of Anatomy, University of California.

It is important to know what might be expected to be the normal oestrous behavior of animals reared from the time of weaning on a satisfactory standard diet. For this purpose we have employed a standard ration used by E. V. McCollum, consisting of whole wheat, whole milk powder, casein, salts and 5 per cent butter fat. Many animals have been maintained on this ration as littermate controls of animals on other nutritive regimens, so that there is available for these data the performance of over five hundred individuals. The growth exceeds considerably that reported by other investigators as normal. Daily microscopic observations were made on the vaginal smears. The average time of occurrence of the first oestrous cycle in the group was on the forty-seventh day of life.

Occurrence of first oestrus in 570 individuals

AGE IN DAYS	NUMBER OF INSTANCES	PER CENT
32-36	18	3.1
37-55	459	80.5
56-66	73	12.8
67-94	20	3.5

Length of oestrus cycle in 10,000 instances

(First four cycles in each history are omitted)

LENGTH OF CYCLES IN DAYS	NUMBER OF INSTANCES
3	72
4	3,494
5	3,943
6	1,439
7 and over	1,052
	<hr/> 10,000

General average: 5.4 days.

It will be noted that the sexual maturity of these animals which were maintained on a superior nutrition is precocious when compared with the standards known to the literature. In the majority of cases of exceptionally early maturity

there is a superior growth rate. It is also true that the slowest growers usually mature later. The latter statement is firmly established by our work (not presented here) on quantitative and qualitative under-nutrition which invariably delays sexual maturity.

An examination of the normal curve of growth with reference to the time of establishment of ovulation shows that the rate of growth does not change with this event.

25. Characteristic effects upon growth, oestrus, and ovulation induced by the intraperitoneal administration of fresh anterior hypophyseal substance. HERBERT M. EVANS and JOSEPH A. LONG, University of California.

At the last session we reported acceleration of growth in rats treated daily intraperitoneally with the finely ground, fresh anterior lobe of the hypophysis of beef. There is lack of effects from oral administration of the same substance. Treated animals are invariably heavier than their litter mate sisters. The greatest disparity was attained on the 333rd day of life, when an animal receiving anterior hypophyseal substance weighed 596 grams and its healthy litter mate control weighed 248 grams. It would not appear to be incorrect to characterize these changes as producing constantly a mild degree of gigantism. Increase in weight results to a great extent from a storage of fat, but is not solely due to this, the skeleton being invariably somewhat larger and heavier, and, as would be expected, the heart, lung, alimentary canal and kidney are heavier. The weight of the hypophysis, thyroid and thymus are not appreciably affected.

Oestrus, as detected by typical changes in the vaginal smear, may never occur in these animals or may be exhibited only at long intervals. In all instances the ovaries instead of being underdeveloped weighed twice as much as the control and exhibited great numbers of substantial corpora lutea. The uterus, on the contrary, weighed absolutely about half as much as it did in the normal controls. Histological examination of the gonads showed abundant lutein tissue and demonstrated the formation of this tissue about the egg in unruptured, normal follicles and in atretic follicles. Ripe, normal Graafian follicles were invariably absent. A powerful, specific stimulus to lutein cell transformation has thus been effected by this hormone.

26. A strain of epithelial cells in pure culture. (Lantern.) ALBERT FISCHER, (introduced by E. V. Cowdry), Rockefeller Institute for Medical Research.

By cultivating in vitro parts of the chick embryo lens containing cells from the iris, a pure outgrowth of epithelial cells was successfully obtained. The strain was derived from a little rim of iris which spontaneously adhered to the lens when removed. It has been cultivated for more than two months, and is still proliferating in a way which is characteristic of epithelial growth in vitro. No connective-tissue cells have been observed. The culture medium is the same as has been used for cultivating fibroblasts, but by allowing the cells to multiply on the surface, instead of in the plasma clot, a more extensive growth has been observed. The rate of growth of epithelial cells in vitro is less active than that of fibroblasts, but the number of cultures can be multiplied easily.

27. Preliminary results of rotation of portions of the embryonic spinal cord about its long axis. DAVENPORT HOOKER, University of Pittsburgh School of Medicine.

Previous studies have demonstrated the possibility of reestablishing anatomical and physiological continuity between completely severed portions of the embryonic spinal cord in normal and reversed polarity when the original dorsoventral relations of the components are maintained. The power of the various parts of the cord to reestablish proper connections in cases of poor apposition of the cut ends led to experiments on the reestablishment of continuity between severed segments of the embryonic cord of *Rana* and *Amblystoma* when one segment was rotated on its long axis.

The results of preliminary experiments indicate that it is possible to obtain reestablishment of continuity between a normally oriented cord component and a segment which has been rotated on its long axis through various arcs up to complete inversion (180° rotation). The restoration of physiological continuity has not been conclusively demonstrated. Better healing and continuity of like areas of the cord is obtained when the segment is rotated up to 90° than when rotated more. When rotated 90° , there is a tendency for the regenerated tissue closing the cord wound to rotate through the quarter turn of a spiral to link up the like cord areas. This same tendency is present in rotations of from 90° to 135° , but is not so clearly demonstrable. In at least one case of 180° rotation, there is definite evidence of a motor and sensory fiber decussation in the sagittal plane. There is thus a definite interattraction of like areas of the cord.

28. A note on the ectodermal origin of the spinal ganglia. DAVENPORT HOOKER, University of Pittsburgh School of Medicine.

The results of the writer's experiments in total removal of the nervous system in frog embryos at the time of closing of the neural folds have been criticized by Dart and Shellshear on the ground that the operation necessitated the removal of the dorsal portions of the myotomes from which, according to these investigators, the cells of the spinal cord and ganglia are at least in part derived.

It is practically impossible to remove the entire nervous system in frog embryos at the stage in which the neural folds have just closed without some injury to the myotomes. It is possible to remove the dorsal half of the spinal cord, the neural crest and the covering ectoderm at this stage without the slightest injury to the myotomes. This was done, in the belief that the absence of all nervous elements in the total removal experiments in conjunction with the presence of the majority of myotomic elements proved the ectodermal origin of the ventral horn cells and made it necessary to review only the possible myotomic origin of spinal ganglia elements.

The results of the removal of the dorsal half of the cord, of the neural crest and the ectoderm show that the amount removed is in direct proportion to the size of the spinal ganglia developing, if any. Where little was removed, the ganglia are complete; where the cut went deeper, they are smaller; and where the entire mass was removed, they are absent. The myotomes contribute no elements.

29. *The relation of the thyroid to certain stages of metamorphosis in frog larvae.*

MARGARET MORRIS HOSKINS, University of Arkansas.

The experiments described were made by E. R. Hoskins in 1919, in order to test a theory of the relation of the thyroid to different stages of metamorphosis. It was our belief that the influence of this gland on metamorphosis was through its effect on calcium metabolism. In its absence the skeletal changes do not occur and the lack of these first steps towards the adult form prevents the later changes such as the atrophy of the tail and the shortening of the intestine. In the experiments made in 1919, the thyroid anlage was taken from its normal position and grafted into the tails of the larvae. When the animals had reached their maximum size and had well-developed legs, the tails containing the thyroid grafts were cut off. With few exceptions these thyroidless animals completed metamorphosis. Examination of sections has been made to eliminate all cases in which thyroids regenerated in the normal position, and it was found that although a large percentage of regeneration was present, a number of the frogs were actually thyroidless. It is therefore evident that the thyroid is not directly necessary for the later stages of metamorphosis.

30. *Meningeal relations of hypophysis cerebri.* WALTER HUGHSON, Department of Anatomy, Johns Hopkins Medical School.

Although many workers have commented upon the meningeal investments of the hypophysis, no adequate description of these membranes has been presented. Study of serial sections of this region shows that in addition to the dural covering of the floor of the sella turcica, the hypophysis is completely surrounded by an arachnoid membrane continuous with that of the brain. Similarly the pia is reflected upon the hypophysis investing it closely. Between these two membranes is a space, traversed by many trabeculae so that it becomes close-meshed.

The continuity of this leptomeningeal space about the hypophysis with the cranial subarachnoid space has been demonstrated by two methods of injection. In both of these procedures, injections of a true solution of iron ammonium citrate and sodium ferrocyanide were made into the spinal or bulbar subarachnoid space, with subsequent precipitation of the foreign salts in situ. The first method involved the injection of the solution under rather high pressures; in the second the introduction of foreign solution was accomplished by the reduction of the cerebrospinal fluid pressure by simultaneous intravenous injection of strongly hypertonic solutions of sodium chloride. Under these conditions of injection the precipitated prussian blue granules have been found to surround the hypophysis in a definitive subarachnoid space. In addition these granules may be traced into the substance of the hypophysis itself, entering by way of perivascular channels into the stroma of the pars buccalis and outlining more or less completely the cellular cords. Likewise into the substance of the pars nervosa granules may be similarly traced. In both cases, absorption into the capillary bed seems indicated.

31. *Observations on the femur.* N. W. INGALLS and M. H. GROSSBERG, Laboratory of Anatomy, Western Reserve University.

The possession by the Hamann Museum of a pair of femora of great interest and extreme rarity has directed attention to certain variations in the distal

half of the femoral diaphysis. The femora in question are characterized by their great length and especially by the very marked increase in the transverse diameter of the lower part of the shaft. While these specimens are frankly pathological, the evidence from normal bones seems to indicate that the condition just noted is only a very aggravated case of normal growth disturbance, although the etiological factors may not be the same. A rather extended series of measurements carried out on 100 pairs of femora from male whites between the ages of 18 and 86 shows, among other things, considerable variation in the width of the inferior half of the femoral shaft. Although none of the bones of this series approach in degree of deformity the pair which occasioned the investigation, they show earlier and milder stages of what appears to be a similar process, i.e., an increase in the width of the lower half of the shaft. In well marked cases there is a gradual increase in transverse diameter beginning about the center of the diaphysis, the lower half of the bone is unusually massive and the condyles consequently appear less prominent. The normal processes of growth and remodeling in this part of the bone seem to be especially sensitive or vulnerable. Somewhat similar, but more irregular deformities in this region have been supposed to be of endocrine, possibly thyroid, origin.

32. Changes in body length and in weights of the body and of various organs in atrophic infants. C. M. JACKSON, Institute of Anatomy, University of Minnesota.

Clinical history and autopsy data for twelve cases of death from inanition were used. Ages range from 5 to 255 days; final body weights, 1695 to 3972 grams; body lengths, 47 to 64 cm. In most cases, the data are fairly complete and comparison (using Scammon's norms) permits the following conclusions:

1. The height-weight index (metric) averages 0.0165, range 0.0120-0.0205 (Bardeen's normal, 0.254).
2. The loss in body weight, final compared with maximum recorded during life, averages 19.2 per cent (range 13.7 to 25.5 per cent).
3. The loss in body weight, final compared with normal for corresponding body length, averages 28.5 per cent (range 7.4 to 52.3 per cent). The loss estimated on this basis is greater, due to persistent skeletal growth.
4. The retardation in growth, final body weight being compared with normal for corresponding age, averages 56.8 per cent (range 41.6 to 71.6 per cent).
5. The changes in weights of the individual organs have been calculated, each observed weight being compared with the normals estimated as the corresponding values for, 1) the final body weight; 2) the maximum body weight; 3) the final body length, and, 4) the age. In general the normal weights are progressively greater for these four estimates, with corresponding differences in the relative (percentage) changes in the organ weights.
6. Omitting consideration of the individual organs, it may be stated that the results are in general agreement with those obtained by experimental inanition on animals. The differences may be due partly to the small number of cases and to existing complications in the atrophic infants.

33. *Secretory phenomena in pathological human thyroids.* J. ALBERT KEY, Harvard Medical School.

In hyperactive thyroids the mitochondria and secretion antecedents are increased and can be studied. In a series of fifty pathological thyroids I have studied the mitochondria and secretion granules and vacuoles.

The secretion granules, first differentiated from the mitochondria by Bensley, are round, variable in size and usually in the apical zone of the cell. They are soluble in alcohol, blackened with osmic acid, and are fixed and stained by mitochondrial techniques. They differ from mitochondria in that they are more resistant to acetic acid and are stained by methyl-green, neutral gentian and other stains which do not stain mitochondria.

The secretion vacuoles first seen by Wyss, and termed chromophobe secretion by Anderson, are apparently identical with those described by Bensley. They are variable in size, most abundant in the apical zone of the cell, and appear as clear vacuoles in formalin-bichromate or osmic material. By Bensley's formalin-zenker and brazilin-wasserblau method the vacuoles deep in the protoplasm are preserved and contain a thin coagulum which stains light blue, but the ones in the apical zone are destroyed.

The mode of secretion seems to be that the granules and vacuoles are cast into the vesicle and lose their identity, the granules being dissolved in the fluid like contents of the vacuoles and the mixture forming the colloid which passes back between the cells to be taken up by the lymphatics or blood vessels. The density of the colloid is determined by the relative proportion of the two constituents. The vacuoles are markedly increased in the hyperactive glands and cause the colloid to be thin and contain large vacuoles.

The granules may or may not be increased and their rôle is apparently to form a thickening menstruum to hold the active constituent (contained in the vacuoles) in the vesicles. The mitochondria are definitely increased in hyperactive glands but apparently have to do with the general metabolism of the cell and are not the direct antecedents of the secretion. All three appear to arise independently in the cytoplasm. The colloid cells are senile cells and intracellular colloid droplets are evidence of hypofunction.

34. *Peripheral migration and distribution of cells from the cerebrospinal nervous system in embryos.* ALBERT KUNTZ, St. Louis University School of Medicine.

In embryos of the chick in which the neural crests and the dorsal portions of the neural tube are destroyed by early operation the primordia of the sympathetic trunks arise exclusively from cells of medullary origin which advance peripherally along the paths of the ventral roots of the spinal nerves. Migrant medullary cells also become incorporated in the neurilemma of efferent nerve-fibers. These facts were demonstrated at the last meeting of the American Association of Anatomists.

Further experimental studies indicate that the majority of the cells which become incorporated in the primordia of the sympathetic trunks advance from the intermediate portions of the lateral walls of the neural tube.

In embryos in which the peripheral migration of cells from the cerebrospinal nervous system is prevented throughout the trunk region by early operation the primordia of the oesophageal, pulmonary, cardiac, and enteric plexuses arise

exclusively from cells which advance peripherally along the paths of the vagi. On the other hand, an embryo in which the portions of the hind-brain from which the vagi arise and the greater portion of the vagus ganglia were destroyed by early operation shows complete absence of the primordia of the sympathetic plexuses related to the vagi although the primordia of the sympathetic trunks and the prevertebral plexuses are present.

35. *The innervation of the lung of the rabbit.* O. LARSELL, University of Oregon Medical School.

The bronchial tubes are innervated chiefly by the homolateral vagus, but fibers from the contralateral nerve also have a part in each lung.

The larger bronchi are surrounded by two nerve plexuses. One, composed of relatively large fibers, many myelinated, lies external to the cartilaginous plates. Numerous clusters of ganglionic cells are distributed throughout this plexus. Unmyelinated axonic processes from these cells become arranged into bundles of small size which form a second plexus between the bronchial muscle and the plates of cartilage. The individual fibers subdivide and terminate on the smooth muscle cells. Frequently accompanying these bundles are larger myelinated fibers which lead to sensory terminations in the bronchial epithelium.

In the smaller bronchi the two plexuses become intermingled so closely that only one may be said to be present. Relatively few ganglion cells are found beyond the secondary bronchi, so that the plexus of the smaller bronchi consists chiefly of postganglionic fibers and sensory fibers, whereas the extracartilaginous plexus of the larger bronchi consists chiefly of preganglionic fibers and sensory fibers.

The pulmonary blood-vessels, including the bronchial artery, have a well defined plexus of nerve fibers which terminate in the smooth muscle cells of the tunica media of these vessels.

Myelinated nerve fibers and small nerve terminations, apparently of sensory type, are also present in the pulmonary pleura.

36. *Empirical formulae for the growth curves of the various organs and systems of the single-comb White Leghorn chicken.* H. B. LATIMER, University of Nebraska.

Empirical formulae for the growth curves of one hundred single-comb White Leghorn chickens ranging in age from day of hatching to three hundred days, with six between one and two years old, have the general formula; $Y = (aX)^n \pm bX \pm c$. Y represents the weight of the organ, in grams; a , b , c and n are fixed constants, empirically determined, and X represents the gross body weight in grams. The entire growth curve for some of the organs may be represented by this formula with slight variations of the constants for each curve, and at least the first part of all the curves can be so expressed.

For the organs with a curve which is convex superiorly at first " n " is a decimal fraction. This group includes most of the organs such as the brain, spinal cord, eyeballs, kidneys, etc. In the formula for the thyroid gland, feathers and musculature " n " is greater than unity and the resulting curve is concave superiorly in at least the first part of the curve. The formula for the growth of the integument (without feathers) and for the ligamentous skeleton is a straight line at first.

The upper or terminal portion of many of the curves is a straight line, represented by the general formula $Y = a(X - b) + c$, in which a , b and c are the constants and X the gross body weight.

A sex difference is shown in the growth curve of the feathers and the ligamentous skeleton.

37. Studies on the retina. Histogenesis of the visual cells in *Amblystoma*. HENRY LAURENS and SAMUEL RANDALL DETWILER, Yale University and Pekin Union Medical College.

The first stage in the development of the visual cell is the production of a protoplasmic bud and a clear achromatic globule from the cells of the external nuclear layer. The globule, which becomes the paraboloid of the inner segment, appears to be of cytoplasmic origin. In early stages of the visual cells, masses of deeply staining granules are seen in iron-haematoxylin preparations. These granules contribute mainly to the formation of the ellipsoid of the inner segment and to the granular material of the outer segment. There is no evidence from our preparations which indicates that they are products of pigment ingested from the epithelial layer. They may represent transformation products of mitochondria. In early stages of development, the visual cells are all cone-like, agreeing in this respect with the conditions characteristic of the developing amphibian retina. Rods and cones are later differentiated from the primitive, non-specialized visual cells. Rods do not appear in their definitive form until relatively late. The two kinds of conical-shaped visual elements are regarded as visual cells of low specialization which develop, respectively, into characteristic rods and cones by divergent differentiation.

38. Studies on the ligation of the thoracic duct. F. C. LEE (introduced by Lewis H. Weed), Department of Anatomy, Johns Hopkins Medical School.

a. The establishment of collateral circulation. An operation was devised for the intrathoracic ligation of the thoracic duct in the cat. Subsequent injection of the mesenteric lymphatic vessels while the animal was under an anesthetic showed that two types of collateral circulation were established. One group consisted of those cases in which branches came off of the thoracic duct below its point of ligation and then joined the right thoracic duct. In one animal this connection was seen as a fine branch seven days following ligation; while in another animal which was sacrificed seventy-seven days after ligation, two large trunks coursed to the right thoracic duct. The other group included those cases in which a lymphatico-venous connection was established between the thoracic duct and the azygos vein or its branches. *b. Changes in the number of small lymphocytes in the circulating blood.* Blood counts and smears were made from a series of animals in which the duct had been tied, and it was found that the absolute number of small lymphocytes decreased about sixty per cent immediately following ligation, but that the number gradually returned to normal at the end of three weeks. Examination showed that a collateral circulation had been established.

39. A. *On the influence of symmetry in development, with special reference to the aortic arches of the sheep.* B. *Lantern slides to illustrate the derivation of the term 'hippocampus,' with preparations by Prof. P. E. Lineback.* FREDERIC T. LEWIS, Harvard Medical School.

'Nature abhors a vacuum' is a discredited medieval maxim, serviceable as it was in its day. With similar limitations it may be said that Nature is ill at ease—restless—in the presence of asymmetry, thus expressing a milder reaction, subsiding into apparent contentment when conditions are irremediable. Two examples of this situation, one from plants and one from animals, will be presented. The flowers of *Campanula rapunculoides*, with parts in fives except the carpels, which are three, show many variations interpretable as readjustments. Frequently by the addition of a sixth sepal, petal, and stamen symmetry is restored. A most striking instance in mammalian embryos is the almost complete restoration of a new symmetry, after the first has been destroyed, in the aortic arches of the sheep. The transformation of these vessels has been studied by Dr. G. H. Jackson, Jr., whose results, in part, I am permitted to report. Wax reconstructions of embryos of 10, 14, 15.8, 18, and 47.5 mm. have been made.

If the attainment of symmetry may be regarded as an end in nature, subsequent changes in the great vessels in the pig would seem possible, and the human aortic arches are perhaps further from their ultimate arrangement than those of either pigs or sheep. Such considerations, at least, make it possible to suggest morphological changes in the development of the human body, which, in the course of time, may yet be brought about.

40. *Is mesenchyme or smooth muscle a syncytium or an adherent reticulum?* WARREN H. LEWIS, Carnegie Laboratory of Embryology.

Conclusive evidence on this point cannot be gained from fixed, stained and sectioned material; on the other hand, cultures indicate that the cells of these tissues unite not as a syncytium, but as an adherent reticulum, often similar to that seen in the embryo. One can follow the slow shifting of the cells, the withdrawal of processes from neighboring cells and the sending out of new ones to the same or other cells. Processes attached to the cover-glass only, behave the same as do those attached to neighboring cells except that the former are often more firmly adherent. The processes of mesenchyme cells tend to extend out in all directions and can often be followed in outline (even in fixed cultures) onto neighboring cells or cells beyond these. The processes of smooth muscle cells are usually longer and more pronounced at the two poles and may extend for long distances. There is no evidence of the transfer of material from one cell to another. Both types of cells often become entirely isolated at the periphery of the outgrowths from the rest of the reticulum, their processes being attached solely to the cover-glass. Hypertonic solutions, glycerin and other reagents may cause cells of a reticulum to round up and lose all connections with neighboring cells. In one type of degeneration a similar effect is produced. A renewal of the favorable medium may cause the cells again to expand into an adherent reticulum. Daughter cells do not remain permanently attached to each other.

41. *Survival of cells after death of the animal.* WARREN H. LEWIS and C. C. McCoy, Johns Hopkins Medical School.

All cells live for a period after death. Most of them develop granules and vacuoles which have an affinity for neutral red. When the cells die the color disappears from the granules and vacuoles and the nuclear wall becomes marked. With neutral red as a testing agent various tissues of the rat were examined in spreads. In organs kept at 37°F. large macrophages, cartilage cells, kidney epithelium and smooth muscle, survived for 240 hours; bladder, trachea, tongue and salivary gland epithelium, 192 hours; lymphoid cells and endothelium, 168 hours; lung epithelium, 144 hours; Kupffer cells and leucocytes, 120 hours; sertoli, liver and pancreatic cells and brain macrophages, 96 hours; mesenchyme, ovarian follicular, uterine epithelial and gland cells and red blood corpuscles, 72 hours; and epididymis epithelium, 48 hours. Small pieces of tissue left at room temperature in Locke's solution with neutral red exhibited living macrophages at 144 hours; bladder, tracheal and salivary gland epithelium, smooth muscle and cartilage cells, at 120 hours; mesenchyme and endothelium at 72 hours; ectoderm, lymphoid cells, uterine, pancreatic and lung epithelium, at 48 hours; adrenal cells and leucocytes, at 24 hours; epididymis and intestinal epithelium, ovarian follicular, liver and fat cells, at 18 hours; red blood corpuscles, male germ cells and sertoli cells, at 12 hours. When the entire animal was left at room temperature the periods of survival were much shorter. Nerve cells usually die before granules and vacuoles have a chance to form. Striated muscle always stains diffuse pink.

42. *Studies on the nerve supply to the colon: First showing in the early stages with a model of a 23-mm. embryo.* P. E. LINEBACK, Emory University, School of Medicine.

A study of the appearance and early nature of the nerve supply to the colon, following closely the work done on its musculature, seems logical. This is all the more advisable since the study of both the nerves and muscles in the older, fuller formed state will be greatly facilitated by working with the two simultaneously.

Knowledge of the muscle-nerve mechanism of the colon is of a general sort; it being commonly accepted that the nerves are entirely derived from the sympathetic system. Lynch and Draper have suggested that there might be some degree of nerve control in the caecal end of the tube derived from the mesenteric plexuses, hence a *vagus admixture*.

In conjunction with the above unsettled point there is the problem of the detailed distribution of the nerves to the saccules and taeniae. It has been shown that independent segmental contraction occurs in the three rows of saccules and it is reasonable to infer that there is an independent nerve supply to each. Such details are lacking in the literature and it is the purpose of the author to pursue this line of investigation, beginning with the earliest appearance of nerves in the embryo.

As shown by the 23-mm. model two large nerves grow out from the hypogastric plexus and extend along the tube, forward. These are more prominent and advanced than those from the mesenteric plexuses in the caecal end. This is in harmony with the origin and line of growth of the muscles.

43. *The effect of the ablation of the superior cervical sympathetic ganglia upon the continuance of life.* M. LAURENCE MONTGOMERY (introduced by P. E. Smith), Department of Anatomy, University of California.

In a recent paper Meltzer has stated that the cat and rabbit usually die within a few days if both superior cervical sympathetic ganglia are ablated. Evidence derived from transplantations inclined this author to believe that these ganglia elaborate a principle peculiar to themselves and which is essential to the life of the animal. I have tested this point in a total of eighteen animals, in the rat, cat, and rabbit. All my animals, save one cat, survived the ablation of these ganglia. The cats and rabbits were tested for the presence or absence of these bodies by the 'paradoxical' eye reflex of Meltzer. It is true that the majority of such animals give this reaction. At the autopsy performed when the animals were sacrificed fourteen to sixty-eight days after the operation the tissue at the site of operation was removed, later being serially sectioned and examined histologically. No superior sympathetic ganglionic tissue was present in most cases. This shows that these bodies are not essential to life in these animals and that they do not elaborate an essential secretion peculiar to themselves.

44. *A preliminary report on a radiographic study of the position of the stomach and other abdominal viscera in healthy young adults.* ROBERT ORTON MOODY and R. G. VAN NURS, University of California, and W. E. CHAMBERLAIN, Leland Stanford Junior University.

This study of three hundred students, an equal number of men and women, shows that in 90 per cent of the women and 81 per cent of the men, in the erect posture, the most caudal part of the greater curvature of the stomach is caudad to a line connecting the highest part of the iliac crests (interiliac line).

The most cephalic position found of this part of the greater curvature is 6 cm. cephalad of the interiliac line and the most caudal position 12 cm. caudad to this line. Dividing this distance into quarters, the position of the most caudal part of the greater curvature is shown in the following table, + indicating the distance in centimeters cephalad and - indicating the distance caudad to the interiliac line.

	+ 6 to + 1.5		+ 1.4 to - 3		- 3.1 to - 7.5		- 7.6 to - 12	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Males.....	16	10	53	35	60	40	21	14
Females..	9	6	45	30	58	38	38	25
Total...	25	8	98	32	118	39	59	19

These results indicate that a low position of the stomach is normal in young adults. It is not ptosis and is not a frequent cause of poor health.

It is also found that, contrary to common belief, the strength of the ventral abdominal musculature and the depth of the lumbar curve are not significant factors in the determination of the position of the stomach.

This problem includes a study of the physical factors that may modify the position of the abdominal viscera. A report on additional cases will be made later.

45. Studies of the estrous cycle in the ox. H. S. MURPHEY, Iowa State College.

A. Diestrurn: Os circular, vagina comparatively dry, very few epithelial cells, practically no leucocytes.

B. Estrum: Pro-estrurn: 1. Bright cherry-red color of vestibule due to congestion of bulbus vestibuli. 2. Enlargement of vaginal part of cervix due to swelling of or ripening of mucous cells. 3. Beginning of the outpouring of mucus from the cervical canal. 4. Slight swelling of the vulva. Estrum (or heat): 1. Signs:—bawling, uneasiness, depression of lumbo-sacral articulation; on digital manipulation of clitoris, receptive movements. 2. Swelling of vulva. 3. Vestibule deep red to mahogany. 4. Involuntary contractions of vestibular sphincter. 5. Os uteri, a transverse slit. 6. Great swelling and protrusion into the vagina of the folds of mucous membrane of the cervix. The folding is more marked, and arranged in three to four rows—in old cows mostly two encircling rings—while in virgin heifers mostly one and a half rings. 7. A marked outpouring of clear, viscid, cohesive mucus.

Post-estrurn: 1. A sudden cessation of estrum or heat manifestations. 2. A gradual cessation of the anatomical changes. The vulva becomes wrinkled. The deep color of the vestibule remains relatively longer; the enlargement of the cervix gradually subsides; mucus is discharged from the os for two or three days. The vaginal mucus is streaked with or shows white flocculi, later it becomes gummy, sticky and cohesive, it is opalescent. The white material is both epithelial cells and leucocytes. The former are vaginal in origin as are most of the leucocytes; however, some of the latter are present in smears made directly from the os. Microscopically the cells show increasing degeneration step by step with the gumminess of the mucus.

Diestrum:

Estrum: Uterus: 1. Marked congestion. 2. Edematous, glassy, mucous membrane folded in hillock fashion. 3. Petechiae on both the cotyledonous and intercotyledonary mucous membrane.

46. Dorsal and ventral implantation of the limb bud. J. S. NICHOLAS, University of Pittsburgh School of Medicine. (From the Osborn Zoological Laboratory, Yale University, and the University of Pittsburgh.)

The limb bud has been transplanted to the ventral and dorsal midlines in order to test the rules of limb asymmetry. The growth of the limb so implanted is seldom typical and the limb is generally resorbed.

The two cases in which limbs developed, one in the ventral and one in the dorsal location, gave rise to two perfect limbs. These cases are in accord with Harrison's rules for limb behavior, for under the conditions of implantation the limb bud was located half on the right and half on the left side of the animal. The limbs are morphologically complete in every respect. The girdles of the two limbs are fused, the central portion being common to both members.

The ventral limbs are innervated apparently by the rami supplying the ventrolateral musculature. There is no increase in the peripheral distribution of the

normal nerves from the plexuses of the normal limbs. Below the dorsally implanted limbs numerous mitoses are found in the cord which shows definite hyperplasia. The sensory ganglia are found dorsal to their regular location. This hyperplasia and displacement of the sensory ganglia cannot be said to be due to operative defect, for other animals in which the limb resorbed were operated in the same manner but no hyperplasia exists in any of the cases so far examined. It may be assumed that there has been a definite influence exerted by the limbs developing in the dorsal location which has caused hyperplasia.

47. *The effect of the rotation of the area surrounding the limb bud.* J. S. NICHOLAS, University of Pittsburgh School of Medicine. (From the Osborn Zoological Laboratory, Yale University, and the University of Pittsburgh.)

Since it has been shown that the limb bud tends to recover its normal posture during its development after the rotation of the embryonic rudiment, the next step is to locate the factors which take part in the process of recovery.

By using a double operation with the rotation of the area surrounding the limb bud, the relationships of both the normal limb area and the surrounding portions have been tested. The complete operative disc is five somites in diameter, of which the central three and one-half somites are occupied by the limb bud.

The results of these operations show that in the course of development, the area surrounding the limb bud controls the postural relationship of the developing limb. The limbs produced are normal except for the posture which they assume. When the limb bud is oriented normally with reference to the embryo, but the surrounding tissue is rotated, the limb is rotated during its development so that it assumes its posture with reference to the surrounding area and not to the organism as a whole. This occurs in both the orthotopic and heterotopic locations, thus showing that the factors causing the rotation of the limb are located in the area normally surrounding the limb.

Further experiments will be carried out to show definitely the development of the parts which are located in the area surrounding the limb and also to show the specific influence of the individual components during the course of their development.

48. *An anthropometric study of a group of Syrians in the United States.* G. J. NOBACK, Medical College of Virginia.

This study was made with the object of determining the physical characteristics of one of the peoples of recent migration to the United States. The lack of this information regarding the Syrians led to this study in Minneapolis and St. Paul. One hundred and thirty individuals were measured, of which ninety-four were male and thirty-six were females. Their ages ranged from sixteen to sixty-five years.

The technic and measurements follow closely those practiced in the anthropometric work of the Smithsonian Institution (Hrdlicka, '21). Twenty-two measurements and ten other observations were made on each individual, and ten indices were determined.

Most of the individuals were from the Lebanon and were from mountain and plain. It is believed that our conclusions apply to all of the middle third of Syria.

In stature this group of people is medium-tall according to the classification of heights by Martin and are 2.7 above the world average of Bean. The skeletal index is 52.9; i.e., 2.9 above the index for the world. The cephalic index is 87.5; i.e., Brachycephalic and 7.5 above the world average of Bean. The nose is Leptorhine, index being 65.4, and 14.6 less than world average of Bean. The facial index is 91.5; i.e., Leptoprosopic. The nose is straight or slightly convex in 94 per cent of the cases; the hair color is brunette in all but one (pure blond) case; the eyes predominantly brown though there are four pure blue and eighteen with some degree of blueness.

The teeth show a poorer condition in those born in the United States on comparison with a similar age group of those born in Syria.

49. *On the ossification of the cartilages of the human larynx.* G. J. NOBACK, The Medical College of Virginia.

Previous to Chievitz ('82) it was believed that ossification of these cartilages did not occur before middle life. Investigators were divided as to its significance. Some believed it a normal development, others that it had some relation to disease. Chievitz stated that it was a normal process and that ossification of the laryngeal cartilages is present in all males over twenty, and in all females over twenty-two years of age. Scheier ('01) states that it is a normal process beginning at the same time in both sexes and that he observed ossification in a girl nineteen years old. Text-books follow Chievitz mainly, though some state that this ossification appears at twenty-five years and others that it appears after middle age.

Material used in this study consists of 34 cadaver larynges cleared with KOH and 13 cadaver larynges of which x-rays were made, x-rays of the cervical region of 33 individuals in normal health, and x-rays of 48 persons with chronic tuberculosis.

The present study shows that ossification in the laryngeal cartilages may occur earlier than previously believed. It is demonstrable in the x-ray picture of a boy of seventeen years and in that of a girl of the same age.

Since those individuals showing earliest ossification have chronic tuberculosis and since individuals with this disease show more frequent and extensive ossification of the laryngeal cartilages it seems that chronic diseases may have an intimate relation to ossification of these cartilages.

50. *Nerve supply of atria of the bovine heart.* JAMES W. PAPEZ, Cornell University.

The bovine atria are supplied by the right and left vago-sympathetic nerves.

The right atrial nerves, three in number, enter along the left wall of the superior vena cava. 1) The largest branch enters the triangular fossa in the atrial septum dorsal to the interatrial band and divides into two. The ventral one (interatrial n.) has a small enlargement from which several filaments are given to the interatrial band, two passing to the left end and one to the right end of the band. The dorsal one (septal n.) has a small enlargement which gives filaments to muscle bundles that radiate from the septum into the walls of both atria. 2) The dorsal branch (right sinus n.) supplies filaments to the musculature of the superior vena cava and in the intercaval region it has an enlargement which gives filaments to the intercaval bundle and muscle bundles around the orifice of the

inferior vena cava. 3) A communicating branch passes dorsal to the right pulmonary veins to form a loop with the left sinus nerve which gives filaments to the dorsal wall of the left atrium and ventricle.

The left atrial nerves enter along the left horn of the sinus venosus (left superior vena cava). 1) The ventral branch has an enlargement at the base of the atrial appendage which distributes filaments to the musculature around the base of the appendage and toward the septum. 2) The lateral branch is distributed to the left and dorsal surface of the atrium. 3) The dorsal branch is distributed along the wall of the left horn of the sinus and communicates with a loop of the right nerve.

51. *Structural factors contributing to acoustic insulation of the end organ.* A. G. POHLMAN, St. Louis University.

The diaphragm-rod theory of sound transmission as presented in part at the past two meetings is opposed to the commonly accepted physiology of the middle and inner ear complexes. The usual theories assume a displacement factor in the perilymph as the activating agent, whereas the writer contends for a direct activation of the auditory cells by the sound pulse itself. Accordingly, the conception of end organ response demands an interpretation on the basis of sound pulse activation. Evidence will be submitted which points to the following: First, that the sound pulse enters the scala vestibuli through diffraction. Second, that the diffracted sound pulse is damped by the relatively small opening through which it passes from the vestibule. Third, that the spiral course of the cochlear structure further limits the amount of energy reaching the region of the helicotrema. Fourth, that the membrana basilaris acts in part as an insulator against the discharge of sound pulses from the otic capsule into the end organ. Fifth, that the vestibular membrane tends to limit the amount of energy transmitted from the scala vestibuli into the cochlear duct.

This conception therefore assumes that the auditory epithelium occupies a relatively sound-proof area except to energies entering through the footplate. It also takes into account the considerably greater energies required to hear the low-pitch tones. It explains the failure of acoustic insulation against high-pitch tones of considerable intensity.

52. *The effects of ultraviolet rays on developing mollusks (Limnaeus).* C. W. M. POYNTER, University of Nebraska, Omaha.

A mercury vapor lamp was used and the apparatus so arranged that the light came from below which permitted the free use of the microscope for continuous observation. Pond snails are particularly adapted for this type of investigation not only on account of their penetrability and excellent visibility but also because their early motility and later heart beat make it possible to study the early effects of sub-lethal doses of the ray.

It must be kept in mind that embryos are more sensitive to the rays at some periods of development than at others if quantitative observations are to be made. From the study of the lethal effects of the rays on a large number of embryos of the same age it was found that the range of resistance within the group was greater than the resistance of the weakest members.

A comparison of short non-lethal doses with continuous cytolyzing doses suggests that one of the effects of the light is to form a phototoxic substance which is cumulative in its effects. These animals do not show a greater heat sensitivity from raying; although they die when placed in higher temperatures it can be shown that it is not because of a specific heat action. The effect of the rays in small doses is frequently spoken of as stimulating, but in this work it seems quite certain that the stimulus is catabolic in character. These animals do not present the same recovery curve reported for parameciae. Very small doses of the ray produce a wide variety of monsters.

53. Differences in the time of developments of centers of ossification in the male and female skeleton. J. W. PRYOR, University of Kentucky.

"The bones of the female ossify in advance of the male. This is measured at first by days, then months, then years" (American Journal of Anatomy, 1907). The above observation was made after the study of five hundred and fifty-four roentgenograms of the hands of children from three months to fourteen years of age. Two hundred of these were under seven years of age. The conclusion was based on the development of centers of ossification in the bones of the carpus; in the epiphyses of the metacarpals, phalanges, and the distal extremity of the radius and ulna. Comparisons were made between brother and sister; twins of the same sex; twins of the opposite sex and the average of male and female hands of the same age. With these findings in view and the conclusions accurate, the first centers of ossification appearing in the embryo would be in the female.

Mall states the first centers of ossification develop in the clavicle at the sixth week. He did not make a distinction between the male and female. It is probable these early centers were in the female. The conclusions in this paper are based upon the study of roentgenograms of one hundred and forty fetuses from ten and one-half weeks to thirty-eight weeks of age, of which seventy-one were male and sixty-nine were female; and one hundred new born babes from a few hours to ten days of age, of which forty-eight were male and fifty-two were female. Very few of the fetuses were under twelve weeks and the early centers could not be compared. The principal points to be compared were the centers of ossification of the calcaneum, the talus, the cuboid in the tarsus, the epiphyses of the distal extremity of the femur, the central extremity of the tibia and centers of ossification of the capitatum and hamatum of the carpus.

54. The distribution of acid cells on the dorsal wall of the stomach. H. E. RADASCH, Jefferson Medical College.

In a previous paper the distribution of acid cells along the greater, lesser and ventral curvatures was carefully worked out. At that time the distribution along the dorsal curvature was not recorded. Thinking that the distribution here might afford some connection with the more prevalent occurrence of gastric ulcer upon the dorsal wall, a special study was made of the distribution of acid cells here.

The average distance along the lesser curvature (from the cardiac orifice) of all human stomachs studied is 63.09 per cent. The average distance along the greater curvature of all human stomachs is 83.29 per cent. The average distance along the ventral curvature is 76.45 per cent. In reference to the dorsal curva-

ture, the average distance from the cardiac orifice that the acid cells extended was 82.76 per cent.

In comparing these distances, it will be seen that the acid cells extend farther along the greater curvature than along the ventral or dorsal curvatures, while the acid cells do not extend along the dorsal curvature to quite the same extent as along the ventral curvature. The areas along these curvatures at which the acid cells cease represent a plane that is not set at a right angle to the axis of the gastric canal, but slopes from the lesser curvature caudad and to the left; the plane as a whole faces cephalad and slightly dorsad.

55. Antidromic conduction considered anatomically. S. W. RANSON, Northwestern University Medical School.

Bayliss has shown that the vasodilator fibers for the limbs run through the dorsal roots and have their cells of origin in the spinal ganglia. He believes that they are sensory fibers with side branches terminating on the blood vessels, and that these fibers conduct afferent impulses centrally and vasodilator impulses antidromically. This conception has received strong support from the work of Bruce, Bardy, Richardson and Wyatt, Januschka, and Krogh. But it has not been proven that the dilator impulses leave the spinal cord by way of the sensory fibers of the dorsal roots and it must not be overlooked that fibers of unknown origin and function enter the spinal ganglia and terminate about the spinal ganglion cells in pericellular plexuses which are practically identical with those found in sympathetic ganglia. It is quite possible that the pericellular plexuses represent the synapses between preganglionic and postganglionic vasodilator neurons.

The theory of antidromic conduction as stated by Bayliss does not allow for any synapse of sympathetic character; but it can easily be shown by the use of nicotine that there is such a synaptic interruption in the vasodilator path. Plethysmographic tracings taken from the hind leg of the cat show that the vasodilator reflex which can normally be obtained by central stimulation of the vagus nerve is eliminated by suitable doses of nicotine. Whether this interruption occurs in the spinal ganglion or at some other point remains to be determined.

56. On the time and mode of transition from the fetal to the postnatal phase of growth in man. (Lantern.) RICHARD E. SCAMMON, Department of Anatomy, University of Minnesota.

The growth of the human body exhibits quite different characteristics in the fetal and the postnatal divisions of the developmental period. The results of a quantitative study of the transition between these phases indicate that the changes which occur may be grouped in two quite distinct classes. The first are the true natal changes associated directly with the shift from intrauterine to extrauterine life. These include modifications in the suprarenals, uterus, stomach, lymphoid tissues and lungs, and the postnatal weight loss and recovery. These changes have certain characters in common: they occur immediately after birth, are of short duration, and take place regardless of the age of the fetus when born. Despite these natal changes the growth of the body as a whole appears little affected by birth and the general course of prenatal growth con-

tinues for some time thereafter. This is demonstrated by the projection by formulae of fetal growth curves into postnatal life and their comparison with observed findings for infants in the same period. It is also indicated by the study of the weight increment curves of premature children in early infancy. The true transition from the fetal to the postnatal course of growth takes place through a second series of changes, much more gradual than the natal changes, which occur mainly in the third trimester of the first year of postnatal life.

57. *A quantitative study of the growth of the human eyeball and optic nerve.* RICHARD E. SCAMMON and ELLERY L. ARMSTRONG, Department of Anatomy and Department of Ophthalmology and Oto-Laryngology, University of Minnesota.

The growth in volume of the eyeball in the fetal period agrees very closely with that of the brain-stem and spinal cord. The growth of the diameters of the eyeball is also very like the lineal growth of the brain-stem and spinal cord and may be expressed by the same general empirical formula: $Y = a [(bX)^c \pm d]$, where Y is the dimension in question, X the body length and a , b , c , and d are constants. The postnatal growth of the eyeball follows more closely that of the cerebrum than that of the brain-stem or spinal cord. The postnatal growth in volume of the eyeball seems to have been distinctly overestimated; our data indicate that the postnatal gain is not over 150 per cent. The eyeball diameters increase 35 to 40 per cent in postnatal life. In the latter part of fetal life the temporal segment of the eyeball grows more rapidly than the nasal segment. The fetal growth of the diameters of the cornea is not like that of the eyeball as a whole, but resembles the growth of the external dimensions of the body. It may be expressed by the general empirical formula for external dimensions: $Y = aX \pm b$ (symbols as in formula above). The postnatal growth of the cornea approaches more closely that of the eyeball, although it is not entirely similar. The fetal growth in length and diameter of the optic nerve bears a simple relation to the increase in body length and may be expressed by the formula just quoted.

58. *The growth of the skeleton in the fetal period as illustrated by a quantitative study of the human mandible.* R. E. SCAMMON and S. J. Z. GANZ, Department of Anatomy, University of Minnesota.

The lineal growth of the human mandible in the fetal period was determined by measurements of 14 dimensions on a series of about 100 specimens. The calculation of the changes in mass were based upon a series of observations by Corrado. These data show that the lineal dimensions of the fetal mandible increase in a direct relation to the growth in the total body length and may be expressed by the general empirical formula: $Y = aX \pm b$, where Y is the dimension in question, X is the body length and a and b are constants. The growth in weight of the mandible, when plotted against body length, forms a typical weight or volume curve expressed by the general empirical formula: $Y = aX^b + c$, where Y is mandible weight in grams, X is body length in cm., and a , b , and c are constants. The various angles of the mandible are extremely variable throughout the fetal period but show no marked change. Thus the mandible, despite its peculiarly intimate relation with the dental follicles, follows the simple laws which are found to be characteristic of the fetal growth of the external bodily

dimensions and of the various parts of the body. Since this holds true for the mandible and is also true for lineal dimensions taken between external bony landmarks it seems safe to conclude that the lineal growth of the skeleton and its parts in the fetal period is proportional to the lineal body growth and that the mass increase of the skeleton follows the same course as the body as a whole, its main parts and the major viscera.

59. The genetic interpretation of abnormalities in the anatomy of the nasolacrimal passageways. J. PARSONS SCHAEFFER, Jefferson Medical College.

From a genetic viewpoint the abnormalities in the anatomy of the nasolacrimal passageways appear to fall into three more or less clearly defined groups: First those that have their basis in rudiment potentials; second those due to early arrests in the development of parts which should proceed from the stem rudiment; and third those due to division of previously continuous parts of the nasolacrimal passageways into discontinuous segments.

Rudiment potentials are encountered which explain such abnormalities as supernumerary lacrimal ducts for one or both eyelids, duplication or triplication of the lacrimal punctum, the slit lacrimal punctum, mucosal ledges and so-called valves within the nasolacrimal passageways, irregularities of contour, diverticula, variations in the anatomy of the lacrimal aperture in the inferior nasal meatus, etc.

Patients are encountered with one or both lacrimal ducts wanting in whole or in part, the connection with the inferior nasal meatus may be defective or wanting, atresias of portions of the nasolacrimal passageways are rather common in the newborn. The cause for the failure of normal development is not clear. So far as the lacrimal ducts are concerned there appears to be a critical period for them shortly after the detachment of the solid epithelial rudiment of the nasolacrimal passageways from its surface connection. If the lacrimal ducts, which normally grow as secondary sprouts from the stem rudiment, fail to show beginning growth shortly after this stage, there appears to be a great likelihood they they will not develop subsequently.

60. The smooth musculature of the afferent veins, and the innervation of the human suprarenal gland. HUBERT SHEPPARD, Atlanta Medical College, Emory University.

The central adrenal vein in man contains a greater amount of smooth muscle tissue than other veins of corresponding caliber. A distribution of the muscle fibers in the afferent veins as well as in occasional accessory veins is peculiar in that most of the fibers are longitudinal and often project into the lumen of the vessels in a rugose or valve-like manner. Only a thin layer of circular fibers can usually be observed lying beneath the endothelium. Nerve plexuses in the capsule distribute to both the cortex and the medulla. Within and about the smooth musculature of the central vein, and in the other veins where smooth muscle is present, minute ganglia with occasional isolated nerve cells are found. The longitudinal fibers projecting into the lumen of the vein are abundantly supplied with minute nerve terminals. Fibrils, exceedingly fine and varicose, also penetrate between and supply the cells of the medullary epithelium. In view of the relation of epinephrin to anaphylactic shock, this abundant smooth muscu-

lature of the afferent veins in the human suprarenal as well as the delicate nerve supply in both the smooth musculature and the medulla would seem to have a direct physiological and clinical significance.

61. Vital staining of human and mammalian blood, with special reference to the separation of the monocytes. MIRIAM E. SIMPSON (introduced by Herbert M. Evans), Department of Anatomy, University of California.

Studies on living blood cells and vital dyes reported at the last meeting of the Association have been brought to completion. (On the reaction of the living blood cells to dyes. M. E. Simpson, Proc. Amer. Assoc. Anat., Anatomical Record, 1921, vol. 21, p. 82.) At that time it was pointed out that certain dyes (especially neutral red, Nile blue sulfate, and brilliant cresyl blue) stained a characteristic set of granules in blood cells termed the segregation granules or segregation apparatus, and furthermore that in this way the monocytes could be separated from the lymphocyte cells. The test has been applied extensively to the blood cells of experimental animals (rabbits) as well as to human material in view of the fact that the tests previously employed to separate these cells in human blood (the Giemsa stain and the oxydase reaction) may be notoriously unreliable with other mammalian blood.

The low content of lymphocytes in the segregation granules and the exceptionally high content of monocytes enables us to separate these cells. Lymphocytes possess from one to eight segregation granules, and in rare instances a few more than this. They contain on the average but three or four of these structures. In the monocytes the granules are always numerous, forty to sixty being a reasonable estimate of the number. The granules can be seen in fresh unaltered living cells without the use of dyes and are especially striking in dark field observations, but they are rendered clearest by supra-vital dyes which accentuate the segregation apparatus. Intermediate types between lymphocytes and monocytes are rare.

62. Indirect Wallerian degeneration not found in all animals. SUTHERLAND SIMPSON, Cornell University Medical College, Ithaca, New York.

The so-called retrograde degeneration, frequently found in some of the fibers in the central end of a divided nerve, is termed by Van Gehuchten 'indirect wallerian degeneration' and is accounted for by him as follows: When the motor root of one of the cranial nerves is divided by a sharp knife all the peripheral fibers, of course, undergo degeneration, but if the animal be kept alive for thirty or forty days after the operation some degenerated fibers may also be demonstrated by the Marchi method in the central end. If instead of making the lesion with a sharp knife he tore out the nerve, i.e., injured it as much as possible, then Van Gehuchten found that all the fibers in the central as well as the peripheral end underwent degeneration. When a nerve fiber is divided its cell of origin reacts and undergoes some degree of chromatolysis which is at its maximum in ten to fifteen days. If the lesion is made with a sharp knife the reaction is less marked, the cell recovers, never having ceased to function as a trophic center for the fiber, but, on the other hand, when the damage is very severe, it does not recover and at a certain stage in its downward course it is no longer able to act as a nutritive center to the fiber and from that time the latter undergoes Wallerian

degeneration. On repeating this work on the rabbit—the animal which Van Gehuchten used—the author is able to corroborate, but fails to obtain similar results in other species.

63. *A new classification of the pigmented tumors based on the cytology of the pigment cells.* DAVID T. SMITH, Johns Hopkins Medical School.

A study of sections from over 300 pigmented tumors from all parts of the human body has shown that these growths may be classified according to whether the tumor cells have produced the pigment or have taken it in as a foreign body. I. True pigmented tumors, in which the pigment is produced by the cells: These pigment granules are always individual, discrete bodies, all of about the same size, shape, and color in a given cell. True pigment tumors arise from pigmented cells belonging to two types of tissue—epithelium and mesothelium. The first type of cell is found in the skin and in the retina. In tissue cultures of the chick these pigmented cells grow as a membrane. They give rise to ordinary benign pigmented moles and to melanotic carcinoma (malignant melanoma). The second type of cell is long and spindle-shaped, with branched processes resembling the chromatophore of the lower animals. It occurs in the choroid of the eye, in membranes of the brain, along the nerve trunks, and in the core of the hair bulb. In chick tissue cultures these cells grow like connective tissue. They give rise to a second type of benign pigmented mole and to malignant melanotic sarcoma. II. Pigmented tumors, in which the pigment is not native to the cell but is taken in as a foreign body, as may be seen in the xanthomata and also in any tumors into which hemorrhage has occurred. In these cells the individual particles of pigment are irregular in size and shape and generally much larger than in the true pigmented tumors, in some instances almost filling the cell. It is evident that cells may sometimes be found in tumors of group I which contain foreign pigment having an origin similar to that found in cells of group II, but cells containing native pigment never occur in the tumors of group II.

64. *The effect of intraperitoneal injection of fresh anterior lobe substance in hypophysectomized tadpoles.* PHILIP E. SMITH and IRENE P. SMITH, Department of Anatomy, University of California.

As is well known, the early ablation of the buccal component of the hypophysis in the tadpole results in a well marked alteration in the pigmentary and endocrine systems, and in a slowing of the growth rate. The feeding of the fresh anterior lobe to these specimens brings about a nearly normal rate of growth, but does not bring to normality the altered pigmentary system, the specimens remaining typically albinous, nor do the internal secretory glands respond to this dietary regime, the thyroid failing to develop normally, the parathyroids being diminished in size, and the adrenal cortex diminished and atypically placed. These specimens do not metamorphose. Evans and Long have shown that the intraperitoneal injection of fresh anterior lobe substance in the normal rat produced a growth rate greatly in excess of the normal. Following their lead, we have tried the intraperitoneal injection of this substance in the hypophysectomized tadpole. Such injections bring about a striking change in the larvae so treated. The pigmentary and endocrine systems as well as the growth rate respond to this treatment. The animals become as dark as the normal but exhibit a slightly

more reddish tone. The adrenal cortex and thyroid do not exhibit the great reduction in size which they characteristically display in the typical albino. These animals reach a size much in excess of the normal. They completely metamorphose. From this it would appear that the successful treatment of individuals suffering from hypophyseal deficiency must be affected by the injection of the active principle of this gland and not by feeding, the treatment now resorted to and which has proven almost uniformly unsuccessful.

65. *The basic anatomical problem presented by achondroplasia and other unusual structural complexes.* CHARLES R. STOCKARD, Cornell University Medical College.

Achondroplasia and certain other peculiar structural conditions occurring in man and higher vertebrates are known in particular cases to be inherited through the male parent. This fact renders it probable that achondroplastic individuals arise fundamentally from new or strange chromosomal complexes. Several investigators have recently been inclined to interpret such conditions as due to some unusual activity on the part of glands of internal secretion. This interpretation is, in a sense, very probably true but a fuller consideration is necessary to determine the actual basic cause of the conditions.

Among lower mammals hybridization seems particularly disposed to give rise to such forms and in man this process may also play a part. The specimens in point are most common among chickens and dogs the breeds of which are often derived from more than a single wild species. In short, achondroplasia and similar conditions must be thought of as fundamentally genetic in origin. A mutation occurs and the resulting individuals are in no sense deformed specimens of the common norm.

In the hybrid and mutant individual a unique chromosomal organization was established at fertilization and following development each cell of the body is a new thing containing this strange chromosomal complex. Two propositions now present themselves; they are not antagonistic, and either one or both may be looked upon as explaining the new structural product. As the first possibility, the strange cellular complex of the developing animal may respond in a novel and definite way to the influence of usual or ordinary internal secretions, or in the second place, new and peculiar kinds of secretions may result from the mutation and the presence of these strange substances during development may cause deviations from the racial type, or finally, a combination of these two possibilities might readily obtain. A new breed thus occurs which is capable of perpetuating its characters and is a definite morphological entity or type. These conditions are considered in some detail.

66. *Some notes on the migration of neural crest cells in Rana palustris.* L. S. STONE, Yale University, School of Medicine.

This is a preliminary report of work in progress on normal and operated anuran embryos. Considerable similarity has been found in the wandering of neural crest cells of *Rana palustris* and *Amblystoma punctatum*. However, in *Rana palustris* the crest cells are well defined before the closure of the neural folds and operations involving the removal of these cells must be confined to this period, for at the closure of the folds the crest cells have already begun a rapid ventral

migration. The crest cells are not so easily followed in the earlier stages as in *Amblystoma*. They form the entire visceral skeleton. The removal of neural crest cells in the branchial region produces on that side an absence of the hyobranchial plate, ceratohyal, ceratobranchials and the corresponding half of the basibranchial. There is no contribution of entodermal mesenchyme to the visceral skeleton as in the case of the second basibranchial of *Amblystoma*. The anterior portions of the trabeculae are also formed from neural crest cells. A considerable portion of the connective tissue about the oral region as well as connective tissue in the regions of all the visceral bars is apparently derived from the neural crest.

67. *Significance of the fossa triangularis and cymba conchae.* G. L. STREETER, Department of Embryology, Carnegie Institution of Washington.

The fossa triangularis and the cymba conchae are part of the same structure and constitute an important articular surface of the cartilage of the auricle. As seen from a median view, they form in common a rounded eminence which is closely apposed to the side of the skull, being loosely attached by a fibrous ligament. This articular eminence is strengthened and better support is given to the auricle by the inferior crus of the anthelix, which projects into it as a sulcus from the median side and divides it into halves. The crus helices takes part in the formation of the antero-lateral margin of the eminence.

68. *Hyperpigmentation and so-called blue skin.* R. M. STRONG, Loyola University School of Medicine..

In some cases of hyperpigmentation of human skin essentially no melanin pigment occurs in the epidermis. Numerous melanophores are present, however, in the dermis, especially in the papillae. Such cases, so far as known to the writer, exhibit so-called blue skin. No pathological conditions have been found associated with this pigmental abnormality, though intestinal disorders have preceded in the few cases where the history was available. In ordinary negro skin, there is a brownish tint which is lacking in these dermal pigmentation cases. Epidermal melanin occurs in the form of more or less distinctly separated brown granules. They are responsible for a brown tint. Similar granules occur in the dermal melanophores, but they are so clumped as to appear as a more or less definitely black mass. These melanophores give essentially no color to the light emerging from the skin. A dark gray results which lacks the familiar brownish tint and appears relatively blue. Black mixed with small amounts of white in the color wheel gives a similar affect. Carbon particles and other black foreign bodies inserted in the dermis also produced this appearance. If a real blue tint appears, the turbid medium hypothesis is the best explanation at present available for the blue component.

69. *The fate of the cells contained in the various quadrants of the primitive limb disc.* F. H. SWERT, Osborn Zoological Laboratory, Yale University.

Owing to the totipotence of the fore-limb rudiment of *Amblystoma punctatum*, it is impossible by simple extirpations to determine the portions of the limb formed by the various quadrants. Implantation of markers was attempted without result and the following method was devised. The mesoderm was stained

by heavily overstaining the animals *intra vitam* with Nile blue sulphate; the limb region was then covered with normal ectoderm, and anterior, dorsal, posterior, and ventral 'halves' of such limb rudiments were transplanted to corresponding positions in normal individuals. As the color remained visible until the division between the first two digits had appeared, it was possible to trace the cells to their ultimate positions in the limb. The anterior half contributes to the lateral side of the base, encroaching on the radial border and less on the extensor surface. The dorsal half contributes to the entire limb except the extreme anterolateral prominence of the shoulder. The posterior half contributes to the entire flexor surface and to the dorsum of the tip. The cells of the ventral half are distributed to the most anterolateral prominence of the shoulder and on the body wall ventral to the limb. Thus: 1) The anterodorsal quadrant forms the proximal part of the dorsal surface and radial border, also proximal parts of the shoulder. 2) The dorsoposterior quadrant forms the manus and distal part of the fore arm. 3) The posteroventral quadrant forms the proximal part of the flexor surface and contains cells which remain in the body wall. 4) The anteroventral quadrant contributes to the formation of the shoulder, but most of its cells do not enter the limb.

70. Interrelation of thyroid and pituitary in producing metamorphosis. W. W. SWINGLE, Osborn Zoological Laboratory, Yale University.

Transplantation of the pars anterior of adult frogs into immature larvae (*R. clamata*) with undifferentiated and physiologically inert thyroids, induces rapid growth and differentiation of the limbs, and eventually metamorphosis providing the graft survives. The thyroid apparatus of grafted animals reveals a marked development of the glands; they are larger than those of the controls and composed of large well-formed vesicles. Thyroids of control larvae remain comparatively undifferentiated with scanty colloid content. Pituitary grafts stimulate differentiation and physiological activity of the thyroids. The effect on body growth varies to such an extent interpretation is uncertain; in general results are negative.

Thyroids of large neotenus tadpoles (extra season *R. clamata*, with hind legs 12 mm. long) transplanted into immature 33 mm. larvae without limb buds, induces precocious metamorphosis within thirty-five or forty days, yet such thyroids when left unmolested in the neotenus individuals produce no metamorphic change in the same time interval. In fact such animals commonly pass an extra winter and spring in this stage. The experiment indicates that their thyroids are active and capable of inducing metamorphosis. Obviously, something hinders the release of the fully formed hormone into the blood stream of neotenus larvae. The data suggests some defect of interrelation of the thyroid-pituitary mechanisms. The statement that thyroid transplants from neotenus anurans into undifferentiated larvae induce metamorphosis only up to the stage reached by the larva from which the glands were taken is true only when the time interval is compared with that required by transplanted thyroids of newly metamorphosed frogs to transform similar individuals, other conditions being equal.

71. *Absence of monocytes in thoracic duct lymph.* GEORGE W. THORNE and H. M. EVANS, University of California.

The method of vitally staining leucocytes for the recognition of the monocytes as a distinct mononuclear cell class worked out in this laboratory by M. E. Simpson, has been applied in a study of the thoracic duct lymph. Inasmuch as the normal proportion of monocytes in the blood is low it would appear that the examination of lymph should be carried out in animals in which the proportion of monocytes has been experimentally increased; this may be secured by intravenous treatment of rabbits with some of the benzidine dyes. The monocytes constitute about 8 to 10 per cent of the leucocytes in normal rabbits. The animals were injected intravenously with aqueous solutions of 20 cc. of 1 per cent Niagara Blue at five day intervals. A monocytosis of 20 per cent or more has usually resulted. The vital benzidine dye injections are not always well tolerated. They may in fact cause a leukaemia due predominantly to toxicity to the myeloid cells (amphophils and basophils), and to a slighter extent to the lymphocytes. In such cases, monocytes may be even further increased in proportion and in absolute number. In one such instance there occurred a monocytosis so great that 75 per cent of the circulating leucocytes were monocytes.

It would seem probable from the study that monocytes and lymphocytes are not identical or closely related cell types, and furthermore, that if monocytes are produced in the lymphatic glands along with lymphocyte production, their rate of production is, however, insignificant. It is in fact more probable that the very low monocyte content of lymph is, like its erythrocyte content, due to the invasion of the lymph current by some of the blood elements.

72. *Metamorphosis of the cranium in orang.* T. WINGATE TODD, Western Reserve University.

Measurements* as applied to the cranium are unsatisfactory mainly because the points utilized bear no relation to some common and relatively little variable feature. Underlying all individual, sexual, racial differences there is a common plan of formation, growth and metamorphosis which bears a definite relationship to the common plan in biological groups more comprehensive than the species. In order to discern the fundamental and relatively invariable points in the cranium, growth and metamorphosis must be separated. With Miss Margaret Russell as co-worker, I have chosen the orang as a suitable animal upon which to work out the postnatal metamorphosis of the cranium, first, because it is a giant Anthropoid and, secondly, because the cranial capacity in the adult orang is often no greater than in the animal presenting a full milk dentition. Miss Russell and I have turned our attention first to the cranial base and we find that there are areas of practically no growth (between infancy and adult age) interspersed among areas where great growth takes place, notwithstanding the fact that the cranial capacity is the same. There is therefore considerable movement of one unit of the cranium upon another during this period of life. In spite of these mutual and harmonic changes in relative position of cranial units we find a very steady and definitely predictable position for the external auditory meati and also for certain other points such as the basion and the foramina ovalia. We expect to apply this method to the remainder of the cranium and to other Anthropoids and Man after we have solved the metamorphosis of a cranium comparatively simple because of its meager postnatal increase in cranial capacity.

73. *The influence of feeding anterior lobe of hypophysis on growth and size of Amblystoma tigrinum.* (Lantern.) E. UHLENHUTH (introduced by E. V. Cowdry), Rockefeller Institute for Medical Research, New York.

Up to the present, there are very few experiments which support the view that the feeding of the anterior lobe of hypophysis has any influence on growth and size of the animals. Growth curves and photographs are shown in lantern slides; they demonstrate that anterior lobe, when fed to metamorphosed salamanders of the species *Amblystoma tigrinum*, causes an increase in the rate of growth and size, the animals becoming larger than those fed on other substances. If the animals are given anterior lobe of hypophysis, they grow at a higher rate than those which are fed earthworms. Moreover, they attain a size far in excess of that reached by worm-fed or liver-fed animals, and surpass the largest known animal of the species. At present, the largest hypophysis-fed animal is 19 per cent in excess of the largest liver-fed animal, 25 per cent larger than the largest known normal animal, and 37 per cent larger than the largest worm-fed animal. Liver-feeding causes a rate of growth higher than that resulting from an earthworm diet and equal to that produced by anterior-lobe-feeding. But the liver-fed animals stop growing at a size at which anterior lobe-fed specimens of the same age continue to grow vigorously. Liver-fed animals may grow larger than worm-fed animals and may exceed the size of the largest known animal of the species by as much as 4.7 per cent, but they do not reach the size of hypophysis-fed animals.

74. *The musculature of the stomach of the fetus and newborn.* ELWYN H. WELCH (introduced by R. E. Scammon), Department of Anatomy, University of Minnesota.

The arrangement of gastric musculature of older human fetuses and the newborn may be summarized as follows: 1. The external longitudinal layer is continuous with that of the esophagus and the duodenum. It completely invests the stomach but is very much thinned or even deficient at the mid-point of the dorsal and ventral surfaces. This coat is much heavier over the lesser curvature and in the regions of the cardia and of the pylorus. 2. The so-called middle coat of circular fibers is arranged in concentric rings from the duodenum to the cardia where they are slightly more numerous on the right and superior aspect. Over the fundus these fibers are incomplete and terminate by tucking-in to the circular fibers of the fundus which apparently have a distinctly separate origin. These latter fibers radiate from the center of the fundic dome and completely surround this portion of the stomach. 3. On the left side of the esophageal-cardiac junction, the region of the incisura cardiaca, the oblique or innermost layer bears the same relation as the circular fibers on the right side. This band is continuous above with the deep circular fibers of the esophagus and below with the circular fibers of the fundus. Its fibers course over the lateral wall in the direction of the pylorus ending by turning-in to and becoming a part of the overlying circular layer. At birth some of these fibers can be traced quite to the pylorus.

DEMONSTRATIONS

1. *Radiographs showing the blood supply of the pelvic viscera.* H. S. BURR, School of Medicine, Yale University.
2. *Microscopic preparations showing the transformed bladder muscle.* EBEN J. CAREY, Marquette School of Medicine.
3. *Flagellated thyroid cells in the dog-fish.* E. V. COWDRY, Rockefeller Institute.
4. *Grafts of chick embryo analages in the allantois.* VERA DANCHAKOFF, Columbia University.
5. *Growth of the medullary tube grafted into allantois.* ANNA AGASSIZ and VERA DANCHAKOFF, Columbia University.
6. *Injection of the vascular system of the bone-marrow of the pigeon.* C. A. DOAN (introduced by Florence R. Sabin), Johns Hopkins Medical School.
7. *Demonstration of preparations illustrating a strain of epithelial cells in pure culture.* ALBERT FISCHER (introduced by E. V. Cowdry), Rockefeller Institute for Medical Research.
8. *The effect of the extirpation of the embryonic eye and ear on equilibration in Amblystoma punctatum. Demonstration of live specimens.* WALTER F. GREENE, (introduced by R. G. Harrison), Yale University.
9. *Injected pig embryos dissected and cleared to show the fate of the right dorsal aorta.* CHESTER H. HEUSER, Department of Embryology, Carnegie Institution.
10. *Preliminary results of rotation of portions of the embryonic spinal cord about its long axis.* DAVENPORT HOOKER, University of Pittsburgh School of Medicine.
11. *Slides showing mitochondria and secretion granules and vacuoles in hyperactive human thyroids.* J. ALBERT KEY, Harvard Medical School.
12. *Methylene-blue slides of nerves and nerve-terminations in the lung.* O. LARSELL, University of Oregon Medical School.
13. *Pantographic reproductions of radiographs showing the position of abdominal viscera in healthy young adults.* ROBT. O. MOODY, University of California.
14. *Lantern slide demonstration of congenital abnormality of the hands and right limb.* H. S. MURPHEY, Iowa State College.
15. *Dorsal and ventral implantations of the limb bud.* J. S. NICHOLAS, University of Pittsburgh School of Medicine.
16. *Demonstration of preparations showing the reaction of the iron-containing proteins of the cells of the nucleus hypoglossus following axone injury.* F. M. NICHOLSON (introduced by R. R. Bensley), University of Chicago.
17. *Drawings, cleared specimens, and x-ray pictures illustrating the ossification of the laryngeal cartilages.* G. J. NOBACK, Medical College of Virginia.
18. *Graphs and curves illustrating the prenatal growth of the several parts of the respiratory system in man.* G. J. NOBACK, Medical College of Virginia.

The dissections and measurements were made on a series of specimens, both fresh and preserved, in the collection of the Institute of Anatomy, University of Minnesota. The graphs and curves were made by plotting the measurements against the total body length. The curves approximate straight lines in all but a few of the 46 measurements plotted.

19. Demonstration of sound transmission phenomena. A. G. POHLMAN, St. Louis, University.

These demonstrations require the setting up of apparatus—time and place will be announced. 1. The manner in which the auricle overcomes the damping effect of the external auditory canal (air transmission). 2. The manner in which the stapedial foot-plate enhances a discharge of energy into the perilymph (solid to liquid transmission). 3. The diaphragm-rod theory of sound transmission (air to solid to liquid transmission). 4. The capacity of bone, tendon, elastic and muscle for sound transmission. 5. The piezo-electric reaction of the Rochelle salt transmitter to air, liquid, and solid transmitted sound. The writer expresses his obligation to Dr. F. B. Jewett of the Western Electric Research laboratory, N. Y., for the loan of this transmitter.

20. A preliminary report of a study of the human femur. J. A. POLCZAK and EDWIN J. SIMONS (introduced by G. J. Noback), University of Minnesota.

A series of 248 human femurs have been measured and indexed to date. They consist of 48 fresh (paired) specimens and 200 from the osteological collection of the Institute of Anatomy. They are from peoples of various nationalities but the majority are of Scandinavian origin. The technic employed is the same as that employed by Parsons and by Holtby. The left femur is greater than the right in the following measurements and indices: Maximal Length, Oblique Length, Least Transverse Diameter, Bi-condylar Width, Diameter of the Head; Head Length Index, Platymetric Index, and Pilasteric Index. The above is true of the majority of the left femurs; however, when either femur is found to predominate in any one of its measurements or indices it generally predominates in all the others. The series is not yet completed and further work is being done on sexing.

21. Demonstration of developing blood-cells. FLORENCE R. SABIN, Department of Anatomy, Johns Hopkins Medical School.

22. Field graphs and curves illustrating the growth of the human eyeball and optic nerve. R. E. SCAMMON and E. L. ARMSTRONG, University of Minnesota.

23. Graphs and curves illustrating the transition from the fetal to the postnatal growth phases in man as shown by the projection of empirical formulae of fetal growth and by data on the growth increments of premature infants. R. E. SCAMMON, University of Minnesota.

24. Graphs and curves illustrating the prenatal growth of the human mandible. R. E. SCAMMON and S. J. Z. GANZ, University of Minnesota.

25. An orthoscopic apparatus for graphic reconstruction. R. E. SCAMMON, University of Minnesota.

26. Graphs and reconstructions illustrating the topography of the abdominal viscera in later embryonic and in fetal life. A. L. CAMERON, University of Minnesota.

27. Graphs and curves of the postnatal growth of the human brain and spinal cord. R. E. SCAMMON and H. L. DUNN, University of Minnesota.

28. Graphs, curves and empirical formulae of surface area in man and animals. H. L. DUNN (introduced by R. E. Scammon), University of Minnesota.

29. Preparations to show the effects of inanition upon the mitochondria in the gastrointestinal mucosa and in the pancreas of the albino rat. SHIRLEY P. MILLER (introduced by C. M. Jackson), University of Minnesota.

30. *Graphs illustrating the postnatal growth in weight of the various organs and parts of the guinea pig.* A. N. BESSESEN, JR. and H. A. CARLSON (introduced by C. M. JACKSON), University of Minnesota.
31. *Gross sections of an infant prepared and mounted by the glycerine-gelatine picture-frame method.* CARL CASKEY SPEIDEL, University of Virginia; and ROY M. HOOVER, New York Orthopaedic Hospital.
32. *Demonstration of human skin showing dermal pigmentation only, and exhibiting the phenomenon of so-called blue skin.* R. M. STRONG, Loyola University School of Medicine.
33. *Cleared embryos illustrating the order, time and rate of ossification in the rat skeleton.* R. M. STRONG, Loyola University School of Medicine.
34. *Radiograph of a syndactylous hand, with an interpretative diagram.* W. E. SULLIVAN, University of Wisconsin.
35. *Dissection of a cod. To illustrate the function of articular discs.* W. E. SULLIVAN, University of Wisconsin.
36. *The effect of anterior lobe-feeding on the size of *Ambystoma tigrinum*.* E. UHLENHUTH (introduced by E. V. Cowdry), Rockefeller Institute for Medical Research.

Live specimens of *Ambystoma tigrinum* are shown to demonstrate the effect of excessive feeding of the anterior lobe of the hypophysis on the size of adult salamanders. The hypophysis-fed salamanders exceed all the control animals in size.

37. *Initial stages in the function of the suprarenal medulla in pig embryos.* M. F. WEYMANN (introduced by C. H. Danforth), Department of Anatomy, Washington University School of Medicine.

Several investigators have maintained that the Henle reaction of cells in the suprarenal medulla is due to the presence of epinephrin in the cytoplasm. Test-tube experiments have tended to confirm this idea, since it is found that the precipitate formed when pure epinephrin is added to Müller's fluid is soluble in the same reagents as are the granules found within the cells showing the Henle reaction. These facts are believed to justify the assumption that the intensity of Henle's reaction furnishes an index of the degree of function in the suprarenal medulla. The specimens exhibited are suprarenal glands from pig embryos in different stages of development, fixed in Müller's fluid, hardened in alcohol, sectioned, and stained with neutral haematoxylin and eosin. This series of specimens indicates that: 1) the assumption of a secretory function by the medullary cells is a gradual process which is not complete until about the 142 mm. stage, after which the reaction appears to be fairly constant; 2) with the beginning of function the cells change in character from a more or less embryonic form with a large loose-meshed nucleus to a more specialized form with a smaller more deeply staining nucleus; 3) cells begin to show the reaction even while outside the cortex and at a considerable distance from their ultimate site; 4) all cells do not begin to function at the same time; 5) a few of them already show signs of function at the 45 mm. stage.

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- SHIELDS, RANDOLPH TUCKER, A.B., M.D., Professor of Histology and Embryology, *School of Medicine, Shantung Christian University, Tsinan, Shantung, China. (Until July 1922—Department of Anatomy, Johns Hopkins Medical School, Baltimore, Md.)*
- SHIMIDZU, YOSHITAKA, M.D., Professor of Gynecology, *Nagasaki Medical College, Nagasaki, Japan.*
- SHUFELDT, R. W., M.D., Major Medical Corps, U. S. A. (Retired), *3356 Eighteenth Street, Washington, D. C.*
- SIMPSON, SUTHERLAND, M.D., D.Sc., F.R.S.E. (Edin.), Professor of Physiology, *Cornell University Medical College, Ithaca, N. Y.*
- SISSON, SEPTIMUS, B.S., V.S., Professor of Veterinary Anatomy, *Ohio State University, Columbus, Ohio.*
- SLUDER, GREENFIELD, M.D., Clinical Professor of Laryngology and Rhinology, *Washington University Medical School, 3642 Washington Avenue, St. Louis, Mo.*
- SMITH, BERTRAM GARNER, A.B., Ph.D., Associate Professor of Anatomy, *University and Bellevue Hospital Medical College, 338 East 26th Street, New York City.*
- SMITH, CHRISTIANNA, A.M., Instructor in Zoology, *Mt. Holyoke College, South Hadley, Mass.*
- SMITH, DAVID T., A.B., Medical Student, *Johns Hopkins Medical School, Baltimore, Md.*
- SMITH, GEORGE MILTON, A.B., M.D., Attending Surgeon, *Waterbury Hospital, 111 Buckingham Street, Waterbury, Conn.*
- SMITH, GRAPTON ELLIOT, M.A., M.D., F.R.S., Professor of Anatomy, *University College, Gower St., London, W. C. 1, England.*
- SMITH, H. P., A.B., *Hooper Research Lab., 1332 Sixth Ave., San Francisco, Calif.*
- SMITH, PHILIP EDWARD, M.S., Ph.D., Assistant Professor of Anatomy, *University of California, 1613 Scenic Avenue, Berkeley, Calif.*
- SMITH, WILBUR CLELAND, M.D., Surgeon, *Americus, Ga.*

- SNOW, PERRY G., A.B., M.D., Dean and Professor of Anatomy, *University of Utah Medical School, Salt Lake City, Utah.*
- SPAULDING, M. H., A.M., Assistant Professor of Zoology, *University of Montana, Bozeman, Montana.*
- SPEIDEL, CARL C., Ph.D., Adjunct Professor of Anatomy, *University of Virginia, University, Va.*
- STARK, MARY, Ph.D., Professor of Histology and Embryology, *New York Homeopathic College, New York City.*
- STEVENSON, PAUL H., M.D., Assistant in Anatomy, *Peking Union Medical College, Peking, China.*
- STEWART, CHESTER A., A.M., Ph.D., Fellow in Pediatrics, *Room 121, Millard Hall, University of Minnesota, Minneapolis, Minn.*
- STEWART, FRED WALDORF, A.B., Ph.D., Instructor in Neurology, *Cornell University Medical College, Ithaca, N. Y.*
- STILES, HENRY WILSON, M.D., Professor of Anatomy, *College of Medicine, Syracuse University, 309 Orange Street, Syracuse, N. Y.*
- STOCKARD, CHARLES RUPERT, M.S., Ph.D., Sc.D., (Secretary-Treasurer '14-'21), Professor of Anatomy, *Cornell University Medical College, New York City.*
- STONE, LEON STANSFIELD, Ph.B., Assistant in Anatomy, *Medical College, Yale University, New Haven, Conn.*
- STONE, ROBERT S., B.A., Assistant in Anatomy, *University of Toronto, 40 Wilcox St., Toronto, Ontario, Canada.*
- STOPFORD, JOHN SEBASTIAN B., M.D., Professor of Anatomy, *University of Manchester, Manchester, England.*
- STOTSENBURG, JAMES M., M.D., Instructor in Anatomy, *The Wistar Institute of Anatomy and Biology, Philadelphia, Pa.*
- STREETER, GEORGE L., A.M., M.D., (Ex. Com. '18-'20), Director Department of Embryology, *Carnegie Institution of Washington, Johns Hopkins Medical School, Baltimore, Md.*
- STROMSTEN, FRANK ALBERT, D.Sc., Associate Professor of Animal Biology, *State University of Iowa, 321 East College St., Iowa City, Iowa.*
- STRONG, OLIVER S., A.M., Ph.D., Associate Professor of Neurology, *Columbia University, 437 West 59th Street, New York City.*
- STRONG, REUBEN MYRON, A.M., Ph.D. (Ex. Com. '16-'19), Professor of Anatomy, *Loyola University School of Medicine, 706 South Lincoln Street, Chicago, Ill.*
- SULLIVAN, WALTER EDWARD, A.M., Ph.D., Assistant Professor of Anatomy, *University of Wisconsin, Science Hall, Madison, Wis.*
- SUNDWALL, JOHN, Ph.D., M.D., Professor of Hygiene, *University of Minnesota, Minneapolis, Minn.*
- SUTTON, ALAN CALLENDER, A.B., M.D., *Johns Hopkins Medical School, 3212 Abell Avenue, Baltimore, Md.*
- SWETT, FRANCIS HUNTINGTON, A.M., Assistant, *Osborn Zoological Laboratory, Yale University, New Haven, Conn.*
- SWIFT, CHARLES H., M.D., Ph.D., Assistant Professor of Anatomy, *Department of Anatomy, University of Chicago, Chicago, Ill.*
- SWINGLE, W. W., Ph.D., Assistant Professor of Biology, *Sheffield Scientific School, Yale University, New Haven, Conn.*

- SYKES, GEO. F., Ph.B., M.A., Professor of Zoology and Physiology, *Oregon State Agricultural College, Corvallis, Oregon.*
- TAKENOUCHI, MATSUIRO, M.D., Assistant Professor of Bacteriology and Hygiene, *Medical College, Imperial University of Tokio, Tokio, Japan.*
- TERRY, ROBERT JAMES, A.B., M.D. (Ex. Com. '08-'12, '21-), Professor of Anatomy, *Washington University Medical School, St. Louis, Mo.*
- THOMSON, ARTHUR, M.A., M.B., LL.D., F.R.C.S., Professor of Anatomy, *University of Oxford, Department of Human-Anatomy, Oxford, England.*
- THORKELSON, JACOB, M.D., *Daly Bank Bldg., Anaconda, Montana.*
- THRO, WILLIAM C., A.M., M.D., Professor of Clinical Pathology, *Cornell University Medical College, 28th Street and 1st Avenue, New York City.*
- THÜRINGER, JOSEPH M., M.D., Professor of Histology and Embryology, *University of Oklahoma, Norman, Okla.*
- THYNG, FREDERICK WILBUR, Ph.D., Professor of Anatomy, *Tufts Medical College, 416 Huntington Ave., Boston, Mass.*
- TILNEY, FREDERICK, M.D., Ph.D., Professor of Neurology, *Columbia University, 22 East 63rd Street, New York City.*
- TODD, T. WINGATE, M.B., Ch.B. (Manc.), F.R.C.S. (Eng.), (Vice-Pres. '20'-21), Professor of Anatomy, Medical Department, *Western Reserve University, 1353 East 9th Street, Cleveland, Ohio.*
- TRACY, HENRY C., A.M., Ph.D., Professor of Anatomy, *University of Kansas, Lawrence, Kansas.*
- TUPPER, PAUL YOER, M.D., Clinical Professor of Surgery, *Washington University Medical School, Wall Building, St. Louis, Mo.*
- TURNER, CLARENCE L., M.A., Ph.D., Professor of Zoology, *Beloit College, Beloit, Wisconsin.*
- UHLENHUTH, EDUARD, Ph.D., Associate in Pathology, *Rockefeller Institute for Medical Research, 68th Street and Avenue A, New York City.*
- VANCE, HARRY WELLINGTON, A.B., Medical Student, *Johns Hopkins Medical School, Baltimore, Md.*
- VAN DER HORST, C. J., Ph.D., *Zoologisch Laboratorium, Pl. Muidergracht 34, Amsterdam, Holland.*
- VAN DER STRICHT, OMER, M.D., Professor of Histology and Embryology, *University of Ghent, 11 Marché au lin, Ghent, Belgium.*
- WAITE, FREDERICK CLAYTON, A.M., Ph.D., Professor of Histology and Embryology, *Western Reserve University School of Medicine, 1353 East 9th Street, Cleveland, Ohio.*
- WALLIN, IVAN E., M.A., D.Sc., Professor of Anatomy, *University of Colorado, College of Medicine, Boulder, Colo.*
- WALMSLEY, THOMAS, M.D., Professor of Anatomy, *Queens University of Belfast, Belfast, Ireland.*
- WARREN, JOHN, A.B., M.D., Associate Professor of Anatomy, *Harvard Medical School, Boston, Mass.*
- WATERSTON, DAVID, M.A., M.D., F.R.C.S. Ed., Butte Professor of Anatomy, *University of St. Andrews, St. Andrews, Fife, Scotland.*

- WATKINS, RICHARD WATKIN, B.S., Instructor in Anatomy, *Department of Anatomy, University of Chicago, Chicago, Ill.*
- WATSON, DAVID MEREDITH SEARS, M.Sc., Lecturer in Vertebrate Paleontology, *University College, Gower St., London, W. C. 1, England.*
- WATSON, ERNEST M., A.M., M.D., Instructor in Applied Anatomy, *University of Buffalo, 494 Franklin St., Buffalo, N. Y.*
- WATT, JAMES CRAWFORD, M.A., M.D., Assistant Professor of Anatomy, *University of Toronto, 20 Hawthorne Avenue, Toronto, Canada.*
- WEED, LEWIS HILL, A.M., M.D., (Ex. Com. '20-'21, Sec.-Treas. '22-), Professor of Anatomy, *Johns Hopkins Medical School, Baltimore, Md.*
- WEGEFORTH, PAUL, A.B., M.D., Captain M. C., U. S. A., *Coronado, Calif.*
- WEIDENREICH, FRANZ, M.D., a.o. Professor and Prosector of Anatomy, *formerly 19 Vogesen Street, Strassburg, i Els. France.*
- WEST, RANDOLPH, A.M., M.D., *69 East 93rd St., New York, N. Y.*
- WHITE, HARRY OSCAR, M.D., *University Club, Los Angeles, Calif.*
- WHITESIDE, BEATRICE, Ph.D., Instructor in Anatomy, *Washington University Medical School, St. Louis, Mo.*
- WHITNALL, S. E., M.A., M.D., B.Ch., Professor of Anatomy, *McGill University, Montreal, Canada.*
- WITTENBERG, A. H., M.D., Professor of Anatomy, *College of Medicine, University of Tennessee, Memphis, Tenn.*
- WILDER, HARRIS HAWTHORNE, Ph.D., Professor of Zoölogy, *Smith College, Northampton, Mass.*
- WILHELMJ, CHARLES M., A.B., Teaching Fellow in Anatomy, *St. Louis University Medical School, 1402 South Grand Ave., St. Louis, Mo.*
- WILLIAMS, STEPHEN RIGGS, A.M., Ph.D., Professor of Zoölogy and Geology, *Miami University, 300 East Church Street, Oxford, Ohio.*
- WILLARD, WILLIAM A., A.M., Ph.D., Professor of Anatomy, *University of Nebraska, College of Medicine, 42d Street and Dewey Avenue, Omaha, Neb.*
- WILSON, J. GORDEN, M.A., M.B., C.M. (Edin.), Professor of Otology, *Northwestern University Medical School, 2481 S. Dearborn Street, Chicago, Ill.*
- WILSON, JAMES THOMAS, M.B., F.R.S., Professor of Anatomy, *University of Cambridge, New Museums, Cambridge, England.*
- WILSON, LOUIS BLANCHARD, M.D., Director of Pathology Division, *Mayo Clinic and Mayo Foundation, Professor of Pathology in the University of Minnesota, Mayo Clinic, 330 W. College Street, Rochester, Minn.*
- WISLOCKI, GEORGE B., A.B., M.D., Associate in Anatomy, *Johns Hopkins Medical School, Baltimore, Md.*
- WITHERSPOON, THOMAS CASEY, M.D., *Murray Hospital, Butte, Mont.*
- WOODMAN, A. S., M.D., Assistant Professor of Histology and Embryology, *Boston University School of Medicine, Boston, Mass.*
- WOOLLARD, HERBERT T., M.D., Demonstrator of Anatomy, *University College, Gower St., London, W. C. 1, England.*
- WORCESTER, JOHN LOCKE, M.D., Professor of Anatomy, *University of Washington, 5211-21st Avenue, N.E., Seattle, Wash.*

PROCEEDINGS OF THE AMERICAN SOCIETY OF ZOOLOGISTS

The American Society of Zoölogists held its Nineteenth Annual meeting at the University of Toronto in conjunction with Section F of the American Association, and in association with other biological societies, December 28, 29, and 30, 1921.

Officers for the year were:

President: CHARLES A. KOFOID.

Vice-President: AARON L. TREADWELL.

Secretary-Treasurer: W. C. ALLEE.

Executive Secretary, Genetics Section: L. J. COLE.

Local Committee: A. G. HUNTSMAN, *Chairman*, J. M. D. OLMSTED, LUCY CLEMENS.

Executive Committee: H. V. WILSON, M. M. METCALF, GEORGE LEFEVRE, C. M.

CHILD, GILMAN A. DREW.

Membership on the Council of the A. A. A. S.: C. C. NUTTING and W. C. ALLEE.

*Representatives of the Society in the Division of Biology and Agriculture of the
National Research Council*

	<i>Term expires</i>
F. R. LILLIE.....	1923
WILLIAM PATTEN.....	1924
G. H. PARKER.....	1922

EDITORIAL BOARD OF THE JOURNAL OF MORPHOLOGY

Managing Editor (Term expires 1926).....C. E. McCLUNG

Associate Editors

To serve until 1922.....	{ GARY N. CALKINS J. S. KINGSLEY WILLIAM PATTEN
To serve until 1923.....	{ E. G. CONKLIN M. F. GUYER W. M. WHEELER
To serve until 1924.....	{ C. A. KOFOID F. R. LILLIE J. T. PATTERSON

BUSINESS MEETING

At the annual business meeting the appended report of the Treasurer and the Auditing Committee was accepted and ordered to be placed on file.

Expenditures in 1921

To The Wistar Institute for subscriptions:	
January 6.....	\$68.00
February 25.....	4.50
June 6.....	1,971.50
July 4.....	11.00
August 14.....	48.00
October 25.....	28.00
November 3.....	.50
December 19.....	116.00
	<hr/>
	\$2,247.50
Expenses of office of Secretary-Treasurer:	
Printing nomination blanks.....	\$13.50
To The Wistar Institute for programs, envelopes, etc.....	63.10
Telephone and telegrams.....	10.06
Stenography, typewriting, etc.....	57.00
Stationery.....	1.20
Petty cash.....	18.52
Fare of Secretary-Treasurer to Toronto.....	26.65
Miscellaneous:	
Expenses V. E. Shelford to Des Moines.....	60.50
Overpayment of dues.....	2.50
Foreign exchange.....	3.95
Correction (error of bank clerk).....	10.00
	<hr/>
	\$266.98
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	2,247.50
	<hr/>
Total expenditures.....	\$2,514.48

Receipts in 1921

Balance on hand at last report.....	\$960.00
85 \$5.00 dues.....	425.00
233 \$7.00 dues.....	1,631.00
25 \$11.50 dues.....	287.50
Irregular dues.....	73.34
Interest on savings.....	45.39
	<hr/>
Money held or received in 1921.....	\$3,422.57

Cash on hand, December 26, 1921:

Savings account.....	\$906.96
Checking account.....	1.13
	<hr/>
	\$908.09
Total expenditures in 1921.....	\$2,514.48
Plus cash on hand.....	908.09
	<hr/>
	\$3,422.57

We have examined the accounts of the treasurer and found them correct.

A. S. PEARZE,
CHARLES ZELENY,
Auditing committee.

Probable balance January 1, 1922

Balance, December 26, 1921.....	\$908.09
Approximate interest on savings.....	12.50
Final dividend on trust fund liquidation.....	8.06
	<hr/>
	\$928.65
Bills payable January 1:	
The Wistar Institute for subscriptions.....	80.00
Expenses of Secretary's office.....	40.00
	<hr/>
Probable balance January 1, 1922.....	\$808.65
Balance, January 1, 1921.....	889.30
	<hr/>
Probable loss for the year.....	\$81.71

In addition, there are 31 members or ex-members in arrears for a total of 43 years, aggregating dues amounting to \$293.50.

Election of members

The appended list of zoölogists were duly nominated for membership in the Society, as having shown evidence of continued contribution to zoölogical research, and were elected.

ADOLPH, EDWARD FREDERICK, A.B., Ph.D. (Harvard), Instructor in General Physiology, University of Pittsburgh, *Biology Hall, University of Pittsburgh, Pittsburgh, Pa.*

ALEXANDER, CHARLES PAUL, B.S., Ph.D. (Cornell), Systematic Entomologist for the State Natural History Survey of Illinois, *Natural History Bldg., 316 A, Urbana, Illinois.*

ALLEN, WILLIAM RAY, A.B., A.M., Ph.D. (Indiana), Associate Professor of Zoölogy, University of Akron, *University of Akron, Akron, Ohio.*

BAKER, HORACE BARRINGTON, B.S., Ph.D. (Michigan), Instructor of Zoölogy, University of Pennsylvania, *Zoölogical Laboratory, University of Pennsylvania, Philadelphia, Pa.*

- BLANCHARD, FRANK N., A.B. (Tufts), Ph.D. (Michigan), Instructor in Zoölogy, University of Michigan, *University of Michigan, Ann Arbor, Mich.*
- BODINE, JOSEPH HALL, A.B., Ph.D. (Pennsylvania), Instructor in Zoölogy, University of Pennsylvania, *Zoölogical Laboratory, University of Pennsylvania, Philadelphia, Pa.*
- BOWEN, ROBERT HALL, A.B. (Colby), A.M., Ph.D. (Columbia), Instructor in Zoölogy, Columbia University, *Department of Zoölogy, Columbia University, New York City.*
- CAMERON, ALFRED ERNEST, M.A., B.Sc. (Aberdeen), M.Sc. (Manchester), D.Sc. (Aberdeen), Professor of Zoölogy, University of Saskatchewan, *816, Lansdowne Avenue, Saskatoon, Sask.*
- COLE, WILLIAM H (ARDER), A.B., A.M., Ph.D. (Harvard), Professor of Biology, Lake Forest College, *Lake Forest, Illinois.*
- COLLETT, MARY ELIZABETH, A.B. (Wellesley), A.M., Ph.D. (Pennsylvania), Instructor in Physiology, Dept. of Medicine, University of Buffalo, *University of Buffalo (Medical), 24 High Street, Buffalo, N. Y.*
- COWLES, RHEINART P., A.B. (Stanford), Ph.D. (Hopkins), Associate Professor of Zoölogy, *Johns Hopkins University, Baltimore, Md.*
- DAWSON, ALDEN BENJAMIN, A.B. (Acadia), Ph.D. (Harvard), Assistant Professor Microscopical Anatomy, Loyola University School of Medicine, *706 S. Lincoln St., Chicago, Illinois.*
- ELLINGER, TAGE U.H., M.S. (Copenhagen), Statsstipendiat (Danish Government), Fellow of American-Scandinavian Foundation, *1105 Busey Ave., Urbana, Illinois.*
- HOPKINS, HOYT STILSON, A.B., A.M. (Oberlin), Ph.D. (Hopkins), Assistant Professor of Physiology, *Baylor Medical College, Dallas, Texas.*
- HUBBS, CARL L., A.B., A.M. (Stanford), Curator and Instructor, *Museum of Zoölogy, University of Michigan, Ann Arbor, Michigan.*
- HUNTER, GEORGE WILLIAM, A.B., A.M. (Williams), Ph.D. (New York University), Professor of Biology, Knox College, *Galesburg, Illinois.*
- LANCEFIELD, DONALD E., A.B. (Reed), M.A., Ph.D. (Columbia), Assistant Professor of Zoölogy, *University of Oregon, Eugene, Oregon.*
- MACARTHUR, JAMES WOOD, A.B. (Oberlin), M.A. (Wabash), Ph.D. (Chicago), Lecturer in Genetics and Experimental Biology, University of Toronto, *Department of Biology, University of Toronto, Toronto, Canada.*
- MC EWEN, ROBERT STANLEY, A.B., A.M. (Western Reserve), Ph.D. (Columbia), Assistant Professor of Zoölogy, Oberlin College, *Spear Laboratory, Oberlin College, Oberlin, Ohio.*
- OKKELBERG, PETER, A.B., A.M. (Minnesota), Ph.D. (Michigan), Assistant Professor of Zoölogy, University of Michigan, *1116 Ferdon Road, Ann Arbor, Mich.*
- PARMENTER, CHARLES LEROY, A.B., M.A. (Southern California), Ph.D. (Pennsylvania), Instructor of Zoölogy, University of Pennsylvania, *Zoölogical Laboratory, University of Pennsylvania, Philadelphia, Pa.*
- PINNEY, MARY EDITH, A.B., A.M. (Kansas State), Ph.D. (Bryn Mawr), Professor of Biology, Lake Erie College, *Painesville, Ohio.*
- REAGAN, FRANKLIN PEARSE, A.B. (Indiana), Ph.D. (Princeton), Assistant Professor of Zoölogy, University of California, Chairman of the Department, *1921-2, 219 East Hall, University of California, Berkeley, California.*

- RHODES, ROBERT C(LINTON), A.B. (Henderson Brown), A.B., A.M., (Vanderbilt), Ph.D. (California), Professor of Biology, *Emory University, Ga.*
- SCHRADER, FRANZ, B.S., Ph.D. (Columbia), Associate in Biology, *Bryn Mawr College, Bryn Mawr, Pa.*
- STEINER, GOTTHOLD, Ph.D. (Berne), Privatdocent in Zoölogy, University of Berne, Seesel Research Fellow, Yale University, 1921-22, *Osborn Zoölogical Laboratory, Yale University, New Haven, Conn.*
- STUNKARD, HORACE W., B.S. (Coe), A.M., Ph.D. (Illinois), Assistant Professor of Zoölogy, *New York University, University Heights, New York City.*
- WEED, LEWIS HILL, A.B., A.M. (Yale), M.D. (Hopkins), Professor of Anatomy, *Johns Hopkins Medical School, Baltimore, Md.*
- WOODWARD, ALVALYN E., A.B., M.S. (Rochester), Ph.D. (Michigan), Demonstrator in Biology, *Amherst College, Amherst, Mass.*
- YOUNG, BENJAMIN P., B.S. (Kansas), Ph.D. (Cornell), Assistant Professor of Zoölogy, *Cornell University, 209 Eddy St., Ithaca, N. Y.*
- YUASA, HACHIRO, B.S. (K.S.A.C.), M.S., Ph.D. (Illinois), Research Entomologist, Illinois State Natural History Survey, *Natural History Bldg., University of Illinois, Urbana, Ill.*

WILLIAM BATESON, Director of the John Innis Horticultural Institution, Morton Park, Surrey, England, and joint guest of The American Society of Zoölogists and The American Association for the Advancement of Science, at Toronto, was elected an honorary fellow of the Society.

The Secretary reported that five members were two years or more in arrears for dues, and these were accordingly no longer members of the Society, according to Art. II, Sec. 3, of the Constitution. Of six members dropped in 1920, three had been reinstated on payment of dues to date. The total membership at present is 357.

Attention of the Society was called to the agreement with the Wistar Institute, which is reprinted below:

The Wistar Journals

It has recently become apparent that some members do not understand the nature of the agreement between the American Society of Zoologists and The Wistar Institute regarding the Wistar journals. For this reason a statement written by Caswell Grave early in 1916, is re-printed here. Professor Grave was Secretary-Treasurer for the Society at the time and was active in the negotiations between the Society and The Wistar Institute which led to the present arrangement.

WHY THE PROPOSITION WAS MADE AND ACCEPTED

From The Wistar Institute standpoint the proposition was made for these reasons:—

- a) To place the Journals in the hands of those who are most active in the promotion of Zoölogical research.
- b) To unite in a "Triple Alliance" the two Societies and an endowed research institute for organized effort in all that pertains to the progress of Zoological science.

A special fund has been raised to accomplish these purposes with the least possible tax upon the individual members of the Society, and to aid in the prompt publication and extensive distribution of the rapidly increasing number of papers accepted for publication.

From the standpoint of the Society it seemed a duty of the Society to come to the aid of American Zoölogical Journals at this time and assist in placing them upon a basis such that they may serve the purposes for which they were established, and provide an adequate means for publishing and distributing the work of American biologists.

A proposition, whereby members of the Society might for \$6.50 receive Journals representing a value of \$42.00, also seemed attractive even to a Zoologist with small salary, and one not to be lightly turned down.

THE AGREEMENT

Between the American Society of Zoölogists and The Wistar Institute there is no formal agreement in this matter, but, in making the proposition, The Wistar Institute stated in its printed circular and in the copy presented at the meeting that this offer is to members only—and that the end aimed at by the Institute will be defeated if the Journals intended only for the reading tables of members are allowed to reach University or College libraries, thus causing the loss of subscriptions made by Institutions at the regular rate; and, in accepting the proposition, the Society morally bound its members not to allow journals, secured by them at the low Society Rate, to be substituted for journals subscribed for by Institutions at *regular rates*.

It is understood, however, that previous subscriptions by members to these journals at regular rates need not be kept up.

In reply to an inquiry whether the Journal proposition could be made to the Society provided 50% or 75% of the membership were guaranteed by the Society to accept, the director of the Wistar Institute stated that the low Society rate on the Journals could be made only in case a sum is paid by the Society equivalent to \$6.50 for each regular member and provided the name of every such member is added to the mailing lists of the journals.

There have been no changes in the agreement with The Wistar Institute since that time, and so far as the present Secretary-Treasurer can learn, the arrangement has worked well. It is certainly true that members of The American Society of Zoölogists get more journals for the money invested than any other Society which supports a publication program, excepting only the Anatomists, who have a similar agreement with The Wistar Institute. It would cost approximately half our annual dues to print and circulate the Announcement, Abstracts, Proceedings and Membership List which under the present arrangement cost about twenty cents per member per year.

The Secretary was instructed to prepare a formal notification blank to be used in informing new members of their election,

of the privileges of members, and their responsibilities with regard to the Society's journal arrangement.

Proposed amendments made in accordance with Article VI of the Constitution, allowing for the separation of the office of Secretary-Treasurer, were adopted. The By-Laws are also amended to the same end. The Constitution and By-Laws, as amended, will be found on pages 134-7.

Report of the Nominating Committee

The Nominating Committee (see Art. III, Sec. 6), composed of M. F. Guyer, S. J. Holmes and J. H. Gerould, report the following nominations:

President—H. H. WILDER.

Vice-President—B. M. ALLEN.

Secretary—W. C. ALLEE.

Treasurer—D. H. TENNENT.

Member Executive Committee—C. A. KOFOID.

Member National Research Council—H. S. JENNINGS.

Three Associate Editors of the Journal of Morphology—L. L. WOODRUFF, G. A. DREW and H. V. NEAL.

Membership in Council, A. A. A. S.—CHARLES ZELENY and H. E. CRAMPTON.

Nominations from the floor were called for; none were presented and the proposed ticket was elected.

In accordance with the resolution adopted at St. Louis, the Executive Committee announced the appointment of A. L. Treadwell and A. A. Schaeffer as members of the Advisory Board to serve four years.

Committee reports

Since the last meeting, President Kofoid appointed S. I. Kornhauser as the representative of the Society in a cooperative movement with the Society of American Bacteriologists to attempt to standardize American dyes for biological purposes. Professor Kornhauser reported that some information had been collected by means of questionnaires at Woods Hole and elsewhere, and requested members to furnish information concerning their experience with American dyes in comparison with standard stains formerly imported. Doctor Kornhauser stated that he was ready to answer inquiries at any time regarding available

American dyes. The Society voted \$25.00 from its funds to defray the expenses incurred in this investigation.

Conference concerning the relations of genetics to the biological societies

Early in 1921 L. J. Cole and R. A. Emerson sent out a circular letter to the officers and members of the Executive Committees of the societies interested calling attention to a movement among the younger geneticists of the country towards the formation of a separate society and suggesting that representatives of the societies now dealing with genetics meet in conference to discuss possible solutions which would give the geneticists the unity they need without causing the formation of another special society.

The conference was held at the University Club in Chicago, Friday, June 3, 1921, and was attended by Allen (President), Cowles, Crocker, L. R. Jones and Trelease of the Botanists; Allee, Cole, Detlefsen, Guyer and F. R. Lillie of the Zoologists and Davis (President) of the Naturalists.

The conference adopted the following recommendations by general consent without a dissenting voice:

1. That the Division of Biology and Agriculture of the National Research Council call a meeting of officers or representatives of biological societies at Toronto to discuss the formation of a federation of biological societies.

2. That sections be formed in the Botanical Society of America and the American Society of Zoologists to have charge of the genetics programs of the societies beginning with the Toronto meeting, under the joint direction of an executive secretary from each society and a single chairman who will be chosen alternately from each society.

Further details in the development of this plan were referred to the secretaries of the two societies.

As a result of the first recommendation, on invitation of the Division of Biology and Agriculture, National Research Council, a conference of the presidents and secretaries of a number of biological organizations met at Toronto with representatives of the Division, on the afternoon preceding the meetings. The resolutions adopted by this conference were presented to the Society by F. R. Lillie, and approved by the Society. The resolutions follow:

Resolved, 1. That it is the sense of this conference that an intersociety conference should be called to study and report upon the feasibility of federation of the biological societies and to develop plans for the said federation.

2. That for the purpose of effecting such an organization, each society, and Sections F and G of the American Association for the Advancement of Science, be requested to designate its President and Secretary as members of an inter-

society council which shall be authorized, 1) to deal with all matters of common interest, such as pooling of programs, that are consistent with the existing regulations of the constituent societies, and, 2) to draw up proposals for a constitution and by-laws of a federation of the societies in question, and to present them for action at the next annual meeting.

Although no formal action was taken, it was understood that the conference raised by the adhering societies should be empowered to invite other organizations to join it later.

In accordance with the second recommendation of the Chicago Conference, the Genetics Sections of the two societies met together in Lecture Theatre 60 A of the Biological Building beginning on Wednesday morning, December 28. The sections were called to order by Dr. R. A. Emerson, Executive Secretary for the Botanists. He at once appointed a committee of three to nominate a chairman for the Toronto meeting. A. F. Blakeslee was nominated and duly elected, taking the chair at once.

In the afternoon, upon motion, the chair appointed L. J. Cole, R. A. Emerson, H. S. Jennings, A. F. Shull, and G. N. Collins a committee to formulate a plan of organization for the Genetics Sections to report on Friday morning.

In the Zoölogists business meeting Friday morning the following action was taken authorizing the formation of a Section in Genetics:

Moved, That authorization be given for the formation of a Genetics Section of the American Society of Zoölogists to coöperate with the similar section established in the Botanical Society of America.

It shall be understood that any member of the American Society of Zoölogists may become a member of the Genetics Section by indication of his desire to that effect.

Any member of the Society submitting a paper on genetics has the right to have it included in the program of the Genetics Section.

The Genetics Section may designate one of its members as a consulting member of the Executive Committee of the American Society of Zoölogists.

The Genetics Sections reconvened following the Business Meeting of the American Society of Zoölogists. The committee on organization submitted the following report:

Articles of organization

Resolved: That the Genetics Sections of the American Society of Zoölogists and the Botanical Society of America organize for the purpose of securing a closer coördination of genetic interests.

The membership shall consist of those members of the two Societies who shall indicate their desire to be affiliated with the Genetics Sections.

The following officers shall be elected at each annual meeting and shall take office at the close of the meeting.

1. A Chairman, to be chosen alternately from the Zoölogical Section and from the Botanical Section.

2. A Secretary, who may be chosen from either Section.

3. A Society Representative, who shall be chosen from the Section other than from that from which the Secretary is chosen.

These three officers shall constitute the Executive Committee of the Genetics Sections.

In addition to his usual duties, the Secretary shall, in consultation with the other members of the Executive Committee and with the Secretaries of the Societies, arrange the program of the meetings.

The Secretary and the Society Representative shall act as the representatives of the Genetics Sections to their respective Societies.

At the annual meeting the Chairman shall, in advance of the business meeting, appoint a Nominating Committee of three to nominate officers for the following year.

These articles were adopted as proposed.

Upon motion, the Chairman appointed the following a committee to nominate officers for the coming year as provided in the Articles of Organization: R. A. Emerson, G. H. Shull, Charles Zeleny.

This committee later announced as nominees:

For Chairman: H. S. JENNINGS.

For Secretary: L. J. COLE.

For Society Representative: B. M. DAVIS.

These were duly elected.

The Secretary reported on the condition of the American Genetics Association and the needs of the *Journal of Heredity*, and stated that efforts would be made to hold a conference between the Executive Committee of the Genetics Sections and the Council of the American Genetics Association to see what steps can be taken for their mutual benefit.

This transcript of the proceedings of the Genetics Sections, together with the report of the papers presented which will be

found elsewhere in these proceedings, was furnished by the Secretary of the Sections, Dr. L. J. Cole.

The following resolution, growing out of the conference concerning a similar organization of parasitologists within the Society was presented and approved:

Resolved, That the Parasitologists assembled at Toronto request the officers representing the Society in the proposed conference on federation of biological societies, and, further, instruct their special representative, should the conference admit one, to urgently request, that the conference arrange for membership in the Section of Parasitology of persons who do not meet the present requirements for membership in the Society of Zoölogists.

The parasitologists appointed C. A. Kofoed as their representative, with B. H. Ransom as alternate.

In accordance with action taken at the last meeting, President Kofoed had appointed V. E. Shelford a delegate from the American Society of Zoölogists to the National Conference on Parks held in Des Moines, Iowa, January 10, 11 and 12, 1921. Dr. Shelford submitted the following report:

While a small number of scientific societies were represented, the conference was well attended, especially by those interested in natural parks for recreation purposes. Their aim is to secure more parks and protect existing ones. Very few of the existing parks and preserves are free from liability to extensive modification through recreation activities, scientific forestry, fires, or exploitation. Even the National Parks must be watched and defended. There are now only a few areas aside from the National Parks which have been set aside with the intention that they should be left in a natural state. Most areas have been and probably will continue to be set aside primarily as recreation parks, or as forest preserves. The main business of those interested in areas to be held in an original state, must of necessity be to get areas set aside within these forest preserves and parks.

The following was made evident by the conference:

1. That the forces interested in the establishment of natural parks and forest preserves for recreation purposes—to make “better citizens through contact with nature” are well organized, and are probably the strongest force operating to secure more parks and protect existing ones.

2. Science has left them quite ignorant of its needs for natural areas and of the practical significance of scientific results which may accrue from study of natural areas. They welcome the idea of biological study “as a further argument for natural tracts.”

3. They are, however, without constructive plans of management of the smaller tracts which will insure them against destruction from over use as recreation

parks. Such plans of management must be based on knowledge of plant and animal ecology which they do not possess.

4. They are engaged in drafting legislation and in advising legislators without the counsel of those interested in preserves for research purposes.

5. It is incumbent upon scientific societies, museums, and Universities to organize and to provide funds which will serve the following purposes: (a) to place information as to the scientific uses, and scientific management of natural areas, into the hands of those individuals and organization working for the preservation of natural conditions (b) to make possible the representation of scientific needs before legislative bodies and officials (c) to provide for furthering the wise selection of new areas, and (d) to make existing areas accessible to scientists by the publication of lists and guide books.

Communications from other organizations

Eugene C. Bingham, of Lafayette College, Chairman of the Metric Committee of the American Chemical Society, urged all Zoölogists to assist in the establishment of metric units for scientific materials, especially in the matter of ordering chemicals by metric units.

Robert M. Yerkes, of the Research Information Service, spoke briefly concerning the purpose and possibilities of that Service. An abstract of his account is published in the Proceedings.

From the Ecological Society of America, December 28, 1921:

To the American Society of Zoölogists:

For several years past the Ecological Society through the present committee has been locating and briefly describing areas in which the original flora and fauna are little disturbed and which are accordingly suitable for scientific research. Some knowledge regarding about 1000 areas in the United States and Canada is on hand, but the degree of modification from the original state must be estimated for each area. It has been proposed to use letters to designate the condition of the flora and figures to designate the condition of the fauna. It has been suggested that there is only one area in the United States which is really in its original condition. This is due to the general destruction of large game.

It is regarded as highly desirable to press the work to completion and publish it at an early date. The funds available from the Ecological Society and from the National Research Council cannot provide for circulating the necessary questionnaires at an early date. The Ecological Society accordingly authorized the committee to request the American Society of Zoölogists to provide for the work of classifying areas from the standpoint of animals, funds up to \$25.00.

The Society of Zoölogists will be given full credit for this work if the request is granted.

Respectfully submitted by

V. E. SHELFORD,
Senior Chairman.

The Society voted that \$25.00 from its funds be placed to the credit of V. E. Shelford for this work, as requested.

General resolutions

The following resolution was adopted and ordered sent to the appropriate officials:

The American Society of Zoölogists, understanding that there is a temporary suspension of certain scientific publications of the U. S. Government, including the Journal of Agricultural Research, the Experiment Station Record, and the Monthly Weather Reports, desires to put on record its very high appreciation of these journals and of their great national and international importance in the field of natural science and would respectfully urge their resumption at as early a date as possible.

The following resolution was adopted:

Resolved, That the Secretary express to President the of the University of Toronto and the local committee on arrangements the high appreciation of the American Society of Zoölogists for the splendid facilities afforded this meeting and for the cordial hospitality shown the members attending.

PROGRAM

WEDNESDAY, DECEMBER 28

- 10:00 A.M. Section A, Lecture Theatre 14, Biological Building. Papers dealing with Embryology, Cytology, and Comparative Anatomy; seven papers presented in full, five of which were discussed. Attendance, 75.
- 10:00 A.M. Section B, Lecture Theatre 60A, Biological Building. Papers on Evolution and Genetics from the Botanical Society of America. Attendance, about 75.
- 2:00 P.M. Section B continued with papers from the American Society of Zoölogists. Attendance, 125 to 150.
- 5:00 P.M. Meeting Executive Committee.
- 8:30 P.M. Public Address before the entire American Association in Convocation Hall by Professor William Bateson, who had been brought over from England on the initiative of the American Society of Zoölogists in coöperation with the American Association. President Kofoid introduced the speaker of the evening.
- 10:00 P.M. Biological Smoker, Hart House. The smoker was arranged by the American Society of Zoölogists. All interested persons were invited to attend. Smokes and cold refreshments were furnished by the Local Committee. Hundreds present.

THURSDAY, DECEMBER 29

- 9:40 A.M. Biological Building, Lecture Theatre 14; Joint meeting with the Ecological Society of America for the presentation and discussion of papers on Ecology and Zoogeography. Eleven papers were presented in full, seven of which were followed by discussion. President S. A. Forbes, of the Ecologists, presided during most of this session. Attendance, 90.
- 2:00 P.M. Section A, Parasitology, Lecture Theatre 14. President Kofoed, presiding. Herbert Rand, Secretary. Eight papers were presented in full. By vote of the Society, B. H. Ransom was given as much time as he needed to show two reels of films for his paper on "A new venture in the field of practical parasitology." At the close of the session, the members present spent about 45 minutes in discussing the problem of organization. The resolution adopted is recorded in the proceedings of the business meeting. Attendance, 45.
- Section B. General and Comparative Physiology. Lecture Theatre 60 A. Vice-President Treadwell presiding. Nine papers presented in full, four of which were followed by discussion. The section voted to receive papers by E. Horne Craigie and W. H. Longley which had arrived too late for inclusion in the general program. Attendance, 24.
- 5:00 P.M. Meeting Executive Committee.

FRIDAY, DECEMBER 30

- 9:30 A.M. Business Session, Lecture Theatre 14. Maximum attendance, about 75. In addition to the business, papers were presented at this session by Robert M. Yerkes. (No. J. 1) and by E. E. Prince, Dominion Commissioner of Fisheries (No. J. 2). The latter was followed by discussion.
- 2:15 P.M. Medical Building, Lecture Theatre 19. Zoölogists' Symposium on *Orthogenesis*. This was participated in by Lawrence Henderson, C. B. Lipman, M. F. Guyer, H. F. Osborn, J. C. Merriam, and William Bateson with some discussion from the chair and from the floor. Attendance, over 220.
- 7:45 P.M. Zoölogists' Dinner in the dining Hall at Knox College, Address, "The Outlook in Genetics" (illustrated), by William Bateson. Attendance, 112.

In coöperation with Botanical Society of America, the American Society of Naturalists, the Ecological Society of America and other interested societies, the Zoölogists participated in a bulletin service whereby members could keep track of the progress of the programs in related societies. The service was arranged by and under the direction of J. R. Schramm, Secretary of the Botanical Society.

LIST OF TITLES

The following titles, contributed for the program, have been grouped and arranged in accordance with rules accepted by the Society.

Papers marked with an asterisk were read by title.

A. EVOLUTION AND GENETICS

Papers from the Botanical Society of America

1. The synthesis of full coloration in Phlox. (4 min.) James P. Kelly.
2. The inheritance of shape in the fruit of the summer squash. (Lantern; 5 min.) Edmund W. Sinnott.
3. Correlated inheritance in wheat of winter-spring habit of growth and rust resistance. (Charts; 10 min.) Olaf S. Aamodt.
4. The linkage relations of the factors for shrunken endosperm *Sh sh*, waxy endosperm *Wx wx* and the aleurone color factor *C c* and *I i* in maize. (Lantern; 15 min.) C. B. Hutchison.
5. Crossing over in F1 maize-teosinte hybrids. (Lantern, 5 min.) L. F. Randolph.
6. Mexican wild relatives of maize. (Lantern, 20 min.) G. N. Collins.
7. Studies of somatic mutations in variegated maize pericarp: I. Relative frequency of dominant somatic mutations in homozygous and in heterozygous variegated pericarp. (Lantern; 15 min.) R. A. Emerson. II. Frequency of mutation in relation to development. (Lantern, 10 min.) W. H. Eyster and E. G. Anderson. III. An interpretation. (Lantern, 10 min.) E. G. Anderson and M. Demerec.
8. Studies on the pollen tubes and abortive ovules of the Globe mutant of *Datura*. (10 min.) J. T. Buchholz and A. F. Blakeslee.
9. The effect of a single gene as compared with that of a single chromosome upon the gross structure of *Datura*. (Lantern; 10 min.) E. W. Sinnott and A. F. Blakeslee.
10. Three new mutations in *Oenothera lamarckiana*. (Lantern; 12 min.) George H. Shull.
11. Variation and mutation in *Pestalozzia Guepini* Desm. (Lantern; 8 min.) Carl D. LaRue.
12. Inheritance of flower types and fertility in the strawberry. (10 min.) W. D. Valleau.
13. The accumulative effect upon a pure line of wheat, of ten generations of growth under diverse conditions of soil fertility. (10 min.) C. H. Myers.
14. The immediate effect of foreign pollen upon the kernel development of maize. (15 min.) T. A. Kisselbach.

A'. EVOLUTION AND GENETICS

Papers from the American Society of Zoologists

1. Relative nuclear volume and the life cycle of *Hydratina senta*. (Lantern.) A. Franklin Shull, University of Michigan.
2. The action of alcohol upon germinal material. (Lantern.) E. Carlton MacDowell, Cold Spring Harbor.

3. Parallelism in Ascidians, with a new conception of organic structure. A. G. Huntsman, University of Toronto.
- *4. Effect of temperature upon the development of the eye of *variable*, a mutant from *Drosophila hydei*. Roscoe R. Hyde. The Johns Hopkins University.
5. Heritable effects of chemically differing media on the fission rate of *Paramecium caudatum*. A. R. Middleton, University of Louisville.
6. Heredity of resistance to tuberculosis in guinea-pigs. (Lantern.) Sewall Wright and Paul A. Lewis, Bureau of Animal Industry and Phipps Institute.
- *7. Data on the inheritance of spurs in the female fowl. H. D. Goodale, Massachusetts Agricultural Experiment Station.
8. Heredity of build. (Lantern.) Charles B. Davenport, Cold Spring Harbor.
9. Effective reverse selection in bar eye of *Drosophila* due to the appearance of mutations. (Lantern.) Charles Zeleny, University of Illinois.
10. Genetic mosaics and ontogenetic abnormalities in the parasitic w. sp, *Hadrobracon*. (Charts.) P. W. Whiting, University of Iowa.
11. Olive, a mutation in *Colias philodice*. John H. Gerould, Dartmouth College.
12. Incomplete synapsis of chromosomes and its possible relation to linkage variations. (Lantern.) C. W. Metz, Carnegie Institution of Washington.
13. A cross in guinea-pigs best explained by assuming 75 per cent crossing over. (Lantern.) Herman L. Ibsen, Kansas State Agricultural College.
14. A linkage diagram of nine factors for color patterns in *Apotettix eurycephalus* Hancock. Robert K. Nabours, Kansas Agricultural Experiment Station.
15. Genetic analysis of low crossover stock, produced by selection. J. A. Detlefsen and L. S. Clemente, University of Illinois.
16. Ten years with the self-fertilized line of *Lymnaea columella* Say. Harold Sellers Colton, University of Pennsylvania.
17. Results of eight years of inbreeding of Rhode Island Red fowls. (Lantern.) L. J. Cole and J. G. Halpin, University of Wisconsin.
- *18. Inheritance of color in the domestic turkey (continued). W. R. B. Robertson, University of Kansas.
- *19. Orthogenesis of non-homochromic pigmentation in Chromodorids. W. J. Crozier, Rutgers College.
- *20. Breeding experiments with the viviparous teleosts, *Xiphophorus helleri* and *Platylocilus maculatus*. (Günth.) A. W. Bellamy, University of Chicago.
21. The elimination of the sex-chromosome by X-rays: A modification of the germ plasm produced by an external agent. James W. Mavor, Union College.
- *22. Hybrid vigor, hybrid weakness and the chromosome mechanism of heredity. An experimental analysis of the physiology of heredity in the reciprocal crosses between two closely associated species of sea-urchins, *Strongylocentrotus purpuratus* and *S. franciscanus*. H. H. Newman, University of Chicago.
- *23. Changes in egg production at the Massachusetts Agricultural Experiment Station. H. D. Goodale, Massachusetts Agricultural Experiment Station.

24. Variations in the number of vertebrae and other segmental characters of fishes correlated with the temperature of the water during development. Carl L. Hubbs, University of Michigan. (Introduced by L. V. Heilbrunn.)
25. (Received by vote of the section.) A lethal gene which changes the order of the loci in the chromosome map. H. J. Muller, University of Texas.

B. EMBRYOLOGY

1. Cell behavior in tissue culture. (Lantern.) H. B. Goodrich, Wesleyan University.
- *2. Experiments with *Necturus* and axolotl thyroids. W. W. Swingle, Yale University.
- *3. Chorionic fusion and augmented twinning in the human tube. Leslie B. Arey, Northwestern University Medical School.
4. The influence of thyroid gland feeding upon tadpoles from which the thyroid gland and the buccal anlage of the hypophysis have been removed. Ben-net M. Allen, University of Kansas.

C. CYTOLOGY

1. A determination of the degree of constancy in the nuclei of certain organs in *Hydatina senta*. H. J. Van Cleave, University of Illinois.
2. Further studies in the cytology of *Asolabis maritima* Bon. (Lantern.) S. I. Kornhauser, Denison University.
- *3. The occurrence of telosynapsis in the male germ cells of *Leptocoris trivittatus* Say (Hemiptera). Harry B. Yocum, University of Oregon.
- *4. Studies on the cells of sheep with special reference to spermatogenesis, oogenesis and sex-determination. (Lantern.) J. E. Wodsdalek, University of Idaho.
5. The structure and division of *Trichomonas augusta*, Alexeieff. D. H. Wenrich, University of Pennsylvania.
6. Multinucleated germ cells in the Columbian ground squirrel. (Lantern.) J. E. Wodsdalek, University of Idaho.
- *7. Seasonal changes in the testis of *Gambusia affinis*, the top-minnow. S. W. Geiser, The Johns Hopkins University. (Introduced by S. O. Mast.)
- *8. Changes in the vaginal epithelium of the guinea pig during the oestrous cycle. R. M. Selle, University of California. (Introduced by J. A. Long.)
- *9. (By vote of the Section, the following papers were received, ordered placed on the program and abstracts were ordered printed.)
The spermatogenesis of man, Theophilus S. Painter, University of Texas.
- *10. The Spermatogenesis of the opossum. Theophilus S. Painter.

D. COMPARATIVE ANATOMY

- *1. Metamorphic changes in the digestive system in *Rana pipiens* and *Amby-stoma tigrinum*. Albert Kuntz, St. Louis University School of Medicine.
2. The skull of *Syngnathus fuscus*. James E. Kindred, Western Reserve University.

- *3. The thyroid glands of perennibranchiate Amphibians. W. W. Swingle, Yale University.
- *4. On the muscular system of *Ornithodoros moubata* (Murray). E. Melville Du Porte, Macdonald College, McGill University.
- 5. On the structure and development of a fat body or gland in the rat. J. A. Long, University of California.
- *6. Relation of growth to metamorphosis in the lungless salamander, *Eurycea bislineata*. Inez Whipple Wilder, Smith College.
- *7. Degeneration in the pelvis of the female pocket gopher, *Geomys bursarius*. Frederick L. Hisaw, Kansas State Agricultural College. (Introduced by J. E. Ackert.)

E. ECOLOGY AND ZOOGEOGRAPHY

- 1. Chemical composition of some fresh-water organisms. C. Juday, University of Wisconsin and Wisconsin Geological and Natural History Survey.
- 2. Some adaptations of mayfly nymphs to swift streams. C. S. Dodds and F. L. Hisaw, West Virginia University.
- 3. Some physical factors related to the distribution of littoral invertebrates. W. C. Allee, University of Chicago.
- 4. Ecology of parasites of lake fishes. A. S. Pearse, University of Wisconsin.
- 5. The eggs of the frogs, tree frogs and toads of Okefinokee Swamp, Georgia. A. H. Wright, Cornell University.
- 6. Further studies on the circulation of water in the Bay of Fundy and the Gulf of Maine. James W. Mavor, Union College.
- 7. The effect of temperature in limiting the geographical range of invertebrates of the Woods Hole littoral. W. C. Allee, University of Chicago.
- 8. Hydrogen ion concentration of Chesapeake bay water. R. P. Cowles and A. M. Schwitalla, S.J., The Johns Hopkins University. (Introduced by S. O. Mast.)
- *9. *Canuella canadensis* and other Canadian copepods. A. Willey, McGill University. (Introduced by A. G. Huntsman.)
- 10. Notes on the Crocodilia of British Guiana. A. M. Reese, University of West Virginia.
- 11. A noteworthy adaptive modification of the webs of a Siamese Agriopid spider. H. E. Crampton.
- 12. On the distribution and ecology of the species of *Partula* inhabiting the Mariana Islands of the Western Pacific Ocean. H. E. Crampton, Barnard College.

F. GENERAL ZOÖLOGY

- 1. On the rate of growth of *Teredo* and *Xylotrya*. (Lantern.) Thurlow C. Nelson, Rutgers College and the New Jersey State Board of Shellfisheries.
- *2. Observations on sex in the top-minnow, *Gambusia affinis*. S. W. Geiser, The Johns Hopkins University. (Introduced by S. O. Mast.)

G. PROTOZOOLOGY

- *1. Trophic and reproductive chromatin in the ciliate infusoria compared with similar conditions in other protozoa. M. M. Metcalf.
- *2. Some effects of conjugation in the life history of *Spathidium spathula*. Lorande Loss Woodruff and Hope Spencer, Yale University.

H. PARASITOLOGY

(All workers in America who have recently published work in parasitology are invited to participate in the parasitology program at Toronto on the same terms as members of the Society.)

- *1. The parasitic Protozoa of *Blatta orientalis* and their value as the material for use in class of parasitic Protozoa. R. Kudo, University of Illinois.
- 2. A preliminary report of the activities of infective hookworm larvae in the soil. William W. Cort and Donald L. Augustine, The Johns Hopkins University.
- *3. Notes on North American blood flukes. G. A. MacCallum, Baltimore.
- *4. A study of *Diphyllbothrium* ova. Meyer Wigdor.
- 5. A new genus of Trematodes from the white-bass. H. J. Van Cleave, University of Illinois.
- *6. Apparent racial immunity to certain Nematode infections. Benjamin Schwartz and Marcos A. Tubangui, University of the Philippines.
- 7. Intestinal protozoan infections as an index of personal hygiene and institutional sanitation. William C. Boeck, University of Wyoming.
- 8. *Ophiotaenia testudo* nov. spec. from *Amyda* (*Trionyx*) *spinifera*. Thomas Byrd Magath, Mayo Clinic.
- 9. Otacariasis in the fox. Wm. A. Riley, University of Minnesota.
- 10. A new venture in the field of practical parasitology. (Motion pictures.) B. H. Ransom, U. S. Bureau of Animal Industry.
- *11. The host-parasite method of investigation and some problems to which it gives approach. M. M. Metcalf.
- *12. The rôle of domestic chickens and pigs in the spread of hookworm disease. James E. Ackert, Kansas State Agricultural College.
- *13. A study of the resistance of different hosts to Trypanosome infections. W. H. and L. G. Taliaferro.
- *14. The anomalies in the group of blood infesting Trematodes. Horace W. Stunkard, New York University.
- 15. Some additional results obtained in the study of infectious anemia of horses. John W. Scott, University of Wyoming.
- *16. Sporulation and development of the cysts in a new species of Myxosporidia, *Lentospora ovalis*. H. S. Davis, University of Florida.
- *17. On the migration of the sheep lung worm, *Dictyocaulus filaria*. John E. Guberlet, Oklahoma Agricultural Experiment Station.
- 18. Studies on *Spirochaeta duttoni* in the tissues of its invertebrate host *Ornithodoros moubata*. E. Melville DuPorte, McGill University.
- *19. A little-worked source for parasite material. M. M. Metcalf.
- 20. A coelomic Coccidian of *Tribolium*. Wm. A. Riley and Laurene Krogh, University of Minnesota.

- *21. On *Leptotheca ohlmacheri*, a Myxosporidian parasitic in frogs. R. Kudo, University of Illinois.
- *22. Notes on two new species of Holostomidae. John E. Guberlet, Oklahoma Agricultural Experiment Station.
- *23. Phases in the life history of a Holostome, *Cyathocotyle orintalis*, nov. spec., with notes on the excretory system of the larva. Ernest Carroll Faust, Peking Union Medical College, Peking, China.

I. COMPARATIVE AND GENERAL PHYSIOLOGY

- *1. Mutual reactions of cell-bodies and pseudopodial fragments of *Diffugia*. Wm. A. Kepner and B. D. Reynolds, University of Virginia.
- *2. Reactions to light of the earthworm, *Lumbricus terrestris*. Walter N. Hess, DePauw University.
- 3. The rate of metabolism of *Paramecium* with controlled bacterial food supply. Geo. T. Hargitt and Ruth L. Phillips, Syracuse University.
- *4. The feeding reactions of *Ambystoma tigrinum* (Green). Albert Kuntz and Jose Zozaya, St. Louis University School of Medicine.
- 5. The rôle of the nervous system in the locomotion and regeneration of marine polyclads. J. M. D. Olmsted, University of Toronto.
- 6. A quantitative study of tarsal sensitivity to solutions of saccharose in the Red Admiral butterfly, *Pyrameis atalanta* (Linn). Dwight E. Minnich, University of Minnesota.
- *7. Micro-Winkler method for quantitative determination of dissolved oxygen. E. J. Lund, University of Minnesota.
- 8. A contribution to the colloid chemistry of protoplasm. L. V. Heilbrunn, University of Michigan.
- *9. Transplantation of the pars nervosa of the pituitary. W. W. Swingle, Osborn Zoological Laboratory, Yale University.
- *10. Photic orientation in the robber-fly, *Proctacanthus*. S. O. Mast, The Johns Hopkins University.
- 11. Light and growth in animals. A. G. Huntsman and F. Fraser, University of Toronto.
- *12. "Reversal of inhibition" in insects, by atropine. W. J. Crozier, Rutgers College.
- *13. Electrical polarity in *Obelia*. E. J. Lund, University of Minnesota.
- *14. Circus movements in negatively heliotropic *Limax*. W. J. Crozier, Rutgers College, and W. H. Cole, Lake Forest College.
- *15. The effect of locomotion in *Ameba*. I. Reactions to localized stimulation. J. Graham Edwards, The Johns Hopkins University. (Introduced by S. O. Mast.)
- *16. A quantitative study of the reactions to light in *Ameba*. Harry T. Folger, The Johns Hopkins University. (Introduced by S. O. Mast.)
- 17. The influence of temperature on the rate of locomotion in *Ameba*. Alphonse M. Schwitalla, St. Louis University. (Introduced by S. O. Mast.)
(Papers received and abstracts ordered printed by vote of the Section)
- 18. The reflex produced by chemical stimulation of the deeper respiratory passages. E. Horne Craigie, University of Toronto.

19. The instincts and adaptations of several species of Tortugas fishes. W. H. Longley, Goucher College.
- *20. Hen feathering in male fowls by feeding thyroid. Benjamin Horning and Harry Beal Torrey, University of Oregon Medical School.

J. UNCLASSIFIED PAPERS

1. The National Research Council Information Service. Robert M. Yerkes.
2. A Rare Example of Fish Teratology in Bicephalous Shark. E. E. Prince, Dominion Commissioner of Fisheries. (Introduced by W. C. Allee.)

SYMPOSIUM ON ORTHOGENESIS

1. Orthogenesis from the Standpoint of the Biochemist. L. J. Henderson.
2. Orthogenesis in Bacteria. C. B. Lipman.
3. Orthogenesis in Serological Reactions. M. F. Guyer.
4. Orthogenesis as Observed from Paleontological Evidence. H. F. Osborn. (Discussion by J. C. Merriam).
5. General Discussion. William Bateson.

EXHIBITS

1. Charts illustrating the elimination of the sex-chromosome from *Drosophila* by X-rays. James W. Mavor, Union College.
2. Charts and Diagrams illustrating the circulation of water in the Bay of Fundy and the Gulf of Maine. James W. Mavor, Union College.
3. A chart showing drift bottles which have crossed the Atlantic from the Canadian Coast since the summer of 1919. James W. Mavor, Union College.
4. The nuclei of the vitellaria of hydatina. H. J. Van Cleave, University of Illinois.
5. A demonstration of decerebrate rigidity, flexion and crossed extension reflexes, reciprocal innervation and inhibition in the cat. J. M. D. Olmsted and W. P. Warner, University of Toronto.
6. A demonstration of *Paramecium calkinsi*, sp. nov. L. L. Woodruff, Yale University.

ABSTRACTS

A. EVOLUTION AND GENETICS

PAPERS FROM THE BOTANICAL SOCIETY OF AMERICA

1. *The synthesis of full-coloration in Phlox.* JAMES P. KELLY, State College, Pa.

In the issue of *Genetics* for March, 1920, the writer published data on color of flower blade in *Phlox Drummondii*. Certain F_1 purples that were full-colored and self-colored gave an F_2 group of several blade types, i.e., full-colored selfs, lighter colored selfs, stippled dusky type, and white-bladed type. The F_2 results showed that the second and third types never gave rise to each other in progeny, while the first might throw out the second and third types besides repeating itself. Such analysis led to inference that full color was due to presence together of second and third types, or, rather of the genes for these types. In the present communication the writer reports the synthesis of full-colored selfs by the putting together in hybridization of the second and third types mentioned above.

2. *Variation and mutation in Pestalozzia Guepini Desm.* CARL D. LA RUE.

The length of spores of *Pestalozzia Guepini* varies from generation to generation. A generation with long spores is followed by two or three generations with spores of reduced size, after which another long-spored generation appears. Fluctuations of a similar type have been found by other workers and have usually been attributed to environmental influences. In *Pestalozzia* the variations appear to be independent of fluctuations in environmental factors. They are likewise independent of the composition of the nutrient medium. One strain of *Pestalozzia Guepini* gave rise to a mutation differing markedly from the parent strain both in spore characters and in vegetative development. From this mutation another originated with vegetative characters like those of the original strain but with spores identical in size and appearance with those of the first mutant. In another strain a mutation arose originated which differs from the parent strain in vegetative characters only.

3. *Correlated inheritance in wheat of winter-spring habit of growth and rust resistance.* (Charts.) OLAF S. AAMODT. Cooperative investigations between the Office of Cereal Investigations, U. S. Dept. of Agriculture, and the Department of Agriculture of the University of Minnesota.

The study is one of the steps leading toward the production of a rust-resistant spring wheat. The parental varieties, Kanred and Marquis, belong to *Triticum vulgare*. Kanred, a winter wheat, is resistant to several biologic forms of *Puccinia graminis tritici* (Ericks. & Henn.) to which Marquis, a spring wheat, is susceptible.

At University Farm, St. Paul, Minnesota, the Kanred parent, when planted in the spring, produces only an occasional head late in the season which fails to set seed. The F_2 Kanred-Marquis cross was planted in the spring and the plants

were placed in nine groups according to time of heading. Seven of these groups set seed and were tested in F_2 . All individuals of the earlier heading F_2 group bred true for spring habit of growth. In the other six groups in F_2 the percentage of spring plants was in direct relation to the time of heading of the F_2 group.

F_2 seedlings of each F_2 group were inoculated, in the greenhouse, with a single known biologic form of rust. The segregation approximated a ratio of three resistant to one susceptible plant. The ratio of resistant to susceptible plants was approximately the same for all heading periods. Preliminary tests indicate that the reaction to several biologic forms was inherited as a single genetic factor.

4. *Studies on the pollen tubes and abortive ovules of the globe mutant of Datura.* J. T. BUCHHOLZ and A. F. BLAKESLEE, University of Arkansas.

A technique of dissection was developed which enables us to stain and count nearly all of the pollen tubes within the nutritive tissue of the style. The pollen from Globe produces upon germination two groups of pollen tubes, those that grow rapidly, and others that grow more slowly, as indicated by the bimodal curve of pollen tube distribution in the style. A large number of abortive ovules are produced in Globe selfed, in Globe Normal, and quite a few even in Normal \times Globe, the latter indicating that probably a number of pollen tubes transmitting the Globe character actually reach the ovary above the small number of Globe seeds produced by this cross. Counts have been made of the pollen applied, the residue of ungerminated pollen grains on stigma and the residue of pollen tubes remaining in the style after abscission, from which the number of pollen tubes entering the ovary may be estimated.

5. *The linkage relations of the factors for shrunken endosperm $Sh\ sh$, waxy endosperm $Wx\ wx$, and the aleurone color factors $C\ c$ and $I\ i$ in maize.* C. B. HUTCHISON.

It has been shown previously by other investigators and by the writer that the factors for waxy endosperm $Wx\ wx$ and shrunken endosperm $Sh\ sh$ and two of the factors concerned in aleurone color, $C\ c$ and $I\ i$ in maize are linked. Results are here reported from two backcross experiments, the one involving shrunken and waxy endosperm and the $I\ i$ color pair, the other shrunken and waxy endosperm and the $C\ c$ color pair, which are interpreted as showing that the order of the genes are $I\ Sh$ and Wx , and $C\ Sh\ Wx$. The per cent of crossovers between I and Sh is practically the same as that between C and Sh . C and I must therefore be allelomorphic or very closely linked.

6. *Studies of somatic mutations in variegated maize pericarp.* I. R. A. EMERSON: Relative frequency of dominant somatic mutations in homozygous and in heterozygous variegated pericarp. 15 minutes. (Lantern.) II. W. H. EYSTER AND E. G. ANDERSON: Frequency of mutation in relation to development. 10 minutes. (Lantern.) III. E. G. ANDERSON and M. DEMEREC: An interpretation. 10 minutes. (Lantern.)

It has been shown previously that there occur, in races of maize with variegated pericarp, somatic mutations from the recessive variegated type to the dominant self-color type, the areas affected varying from a part of a seed to the whole ear. Two types, one inherited and the other not inherited, have been recognized. It has been pointed out that homozygous material, having the recessive variegation factor duplex, might be expected to mutate twice as frequently as hetero-

sygous material having that factor simplex. Results are here reported, showing on the contrary that somatic mutations occur consistently with greater frequency when the variegation factor is simplex than when it is duplex. Tabulation of progenies derived from a gene for variegation shows a high frequency of mutation in both directions, i.e., to self-color and to white. A gene for light variegation mutates frequently to white but rarely to self-color. A gene for dark variegation mutates rarely to white but frequently to self-color. The self-color derivatives show occasional reverse mutations to variegated. The mutations from variegated to self-colored affect both the germ cells and somatic tissue. The effect of a mutation on the somatic tissue of pericarp and glumes is visible as a colored area. The small colored areas are supposed to be due to mutations occurring relatively late in ontogeny, earlier mutations giving rise to larger colored areas. If mutability remains constant the frequency of observed mutant areas of each size should be roughly proportional to the relative number of cells present at the respective stages at which the mutations occurred. Tabulations of about 45,000 observed mutant areas of different sizes show a great increase in mutability in the later stages. This is believed to be causally related to increasing differentiation.

7. *The inheritance of shape in the summer squash.* EDMUND W. SINNOTT.
(No abstract received.)

8. *Three new mutations in Oenothera Lamarckiana.* GEORGE H. SHULL.

The origin and characteristics of the following new mutations are described: 1) *Oenothera Lamarckiana* mut. *funifolia* has strongly revolute leaves and is regarded as a parallel mutation in relation to *Oenothera pratincola* mut. *formosa* Bartlett. 2) *Oenothera Lamarckiana* mut. *pervirens* differs from the parent in having stems and buds wholly devoid of red pigmentation. 3) *Oenothera Lamarckiana* mut. *vetaurea* has flower color modified to a pale old gold color, the only previous departure in flower color in the *Oenotheras* having been to a pale yellowish white known as *sulfurea*. All three of these mutations are recessive to the parental type and at least (1) and (3) originated as new gene-mutations. Mut. *pervirens* may possibly have been produced as result of a crossover. More papers dealing with plant genetics will be added later.

A'. PAPERS FROM THE AMERICAN SOCIETY OF ZOÖLOGISTS

1. *Relative nuclear volume and the life-cycle of Hydatina senta.* (Lantern.)
A. FRANKLIN SHULL, University of Michigan.

The ratio of nuclear volume to cytoplasmic volume, held by many biologists to be of importance in relation to regeneration, age, embryonic development, general cell physiology, sex, and other phenomena, was regarded by Hertwig, Isakowitch, Papanicolaou and others as determining the form of the life-cycle in animals which reproduce alternately by parthenogenesis and bisexual reproduction. The rotifer *Hydatina* offers unusual material for testing this hypothesis. If the theory is correct, the relative nuclear volume should change to correspond with the periodicity of male-production that exists in most lines of this rotifer. Also since male-producers are more common in the middle of a family than at either the beginning or end of it, the nuclear volume should be relatively greater

in middle-aged females than in either young or old adults. Furthermore, those environmental agents (chemical substances, manure solution, food, etc.) which alter the life-cycle should also alter the relative nuclear volume. While significant changes in the volume of the nucleus have been discovered, these changes do not accord with the theory. The relative nuclear volumes in the yolk gland increased during a series of generations, while those of the stomach-intestine decreased during the latter half of the same period. Relative nuclear volume of the yolk gland increased throughout the life of the individual, instead of decreasing after middle age as the theory requires. Manure solution altered the nuclear volume of the stomach-intestine in the direction opposite to that required by the theory, but did not effect the other tissues studied. Female-producers and male-producers appeared to have equal nuclear volumes.

2. *The action of alcohol upon germinal material.* (Lantern.) E. CARLETON MACDOWELL, Station for Experimental Evolution, Cold Spring Harbor, Long Island, New York.

This paper presents a summary of various series of data obtained from white rats heavily dosed with alcohol fumes. Four groups of animals are considered: 1) those treated; 2) their untreated children; 3) their treated children; 4) their untreated children's untreated children. Judged by their behavior in a circular maze and by the size of their litters, all four groups show a small amount of inferiority in comparison with their respective controls. This result appears to support the interpretation that the alcohol has directly modified germinal material.

If the numbers of litters produced in the same periods by the tests and their respective controls are compared, it appears that the treated rats produced only 32 of the expected 91 litters, or 35 per cent of the controls' production. The treated offspring of these treated rats produced 65 per cent of the expected number; the untreated offspring of the treated rats produced 33 per cent more litters than expected and the untreated grandchildren produced 55 per cent more litters than expected. The treated rats grew more slowly than their controls; their treated children about equaled their controls in growth and weight; their untreated children were heavier than their controls and their untreated grandchildren showed a less positive tendency to surpass their controls. The results from weight and the number of litters appear to show that the alcohol has acted as a selective agent upon a series of genetic differences present in the original animals.

3. *Parallelism in Ascidians, with a new conception of organic structure.* A. G. HUNTSMAN, University of Toronto.

Ascidians in general and the family Styelidae in particular offer a very good example of parallelism in the evolution of body-form. In that family the outstanding case is the repeated appearance in distinct genera of a peculiar stalked type. The interpretation offered is that the lines along which evolution has passed have been limited, not by selection, but by the structure of the ancestral germ-plasm. A working conception of the structure of living matter is needed. At present we have knowledge, 1) of the visible structure and, 2) of the chemistry of decomposition products of living matter. These may be loosely connected by considering that corresponding with the definite unity of a living mass there is an

enormous, complex, and ever-changing molecule, which is the foundational and essential part of the mass, and with which are more or less closely associated the numerous simple 'lifeless' molecules of which we have knowledge.

4. *Effect of temperature upon the development of the eye of (variable), a mutant from Drosophila hydei.* ROSCOE R. HYDE, Johns Hopkins University.

The eggs from a new eye mutant, variable from *Drosophila hydei* (Sturtevant) when developed under warm, dry conditions give rise to flies with very small eyes. In fact, the eyes of some individuals may be entirely missing. When the eggs are subjected to a temperature below that of the living room and well supplied with moist food, the flies that emerge have large eyes, indistinguishable from the wild type. The eyes of the wild stock from which mutant came are not modified by changes in temperature. The new eye character is a non sex-linked recessive and shows linkage with scarlet, another mutant of this species. The two characters show crossing over in the female but not in the male.

5. *Heritable effects of chemically differing media on the fission rate of Paramecium caudatum.* A. R. MIDDLETON, University of Louisville.

Can we change the living system by chemical means so that the change will persist in to later generations? To attack this question the organism employed was *Paramecium caudatum* and the character considered is the highly modifiable but heritable fission-rate. For one hundred and thirty days two sets of twenty lines each comprising the two halves of a single clone of *Paramecium caudatum* were kept, one set in 1/32 per cent Horlick's Malted Milk prepared with distilled water and the other in 1/32 per cent Horlick's Malted Milk prepared with 2/10 per cent normal saline. After ten, twenty, thirty, forty, and eighty days' exposure to these chemically diverse environments the two sets were duplicated and kept for ten, twenty, sixty, ninety and fifty days, respectively, in 1/10 per cent normal saline malted milk. During the thirteen ten-day periods of the main experiment the saline lines divided characteristically more rapidly than the distilled-water lines. This relatively faster rate of division of the saline set persisted during ten days' cultivation in intermediate saline subsequent to ten days in extremes, during twenty days in intermediate saline subsequent to twenty days in extremes, and during sixty days in intermediate saline subsequent to thirty days in extremes. An exposure of forty days or longer to extremes produced the reverse effect when the duplicate sets were cultivated in intermediate saline. This result may be due to some undetectable injury resulting from long-continued exposure to relatively high salinity.

6. *Heredity of resistance to tuberculosis in guinea-pigs.* (Lantern.) SEWALL WRIGHT and PAUL A. LEWIS, Bureau of Animal Industry, and Phipps Institute.

The resistance to tuberculosis has been tested in over eleven hundred guinea-pigs belonging to five closely inbred families, the crosses between these families and a random bred control stock. It has been found that sex, and even three-fold differences in age, rate of gain, and weight have only a slight effect on length of life after inoculation. In striking contrast to these negative results, are the great differences among the inbred families, differences which are not correlated with the differences in fertility, weight and vitality. The progeny of crosses are in general at least equal to the better of the two parental families. Resistance

is thus dominant over susceptibility. There is equal transmission by sire and dam and to sons and daughters. In particular crosses, the average of the progeny is consistently superior to either parental line, indicating that the latter are susceptible for different reasons, each being able to supply a dominant resistance factor lacking in the other. In the whole crossbred stock, over 30 per cent of the observed variation is determined by the amount of blood of the best inbred family, as compared with less than 10 per cent due to age, weight and rate of gain combined, and leaving about 60 per cent due to conditions at or following inoculation.

7. *Data on the inheritance of spurs in female fowl.* H. D. GOODALE, Massachusetts Agricultural Experiment Station.

By selection, a race of fowls having spurred females has been produced. Two of these were crossed with a race (Cornish) in which the females are never spurred. F_1 is spurless. Segregation occurred in F_2 , the ratios indicating more than one set of mendelian factors.

8. *Heredity of build.* (Lantern.) CHARLES B. DAVENPORT, Station for Experimental Evolution, Cold Spring Harbor.

A consideration of the best quantitative expression of build; the environmental and general physiological factors influencing build. The hereditary factors determining build and their method of action, together with some discussion of the interdependence of the general physiological and hereditary factors.

9. *Effective reverse selection in bar eye of *Drosophila* due to the appearance of mutations.* (Lantern.) CHARLES ZELENY, University of Illinois.

Reverse selection started in the 34th generation of the high line of the white-bar series was continued for seven generation. An effective decrease in mean facet number was obtained in the first two generations of both females and males and in the seventh generation of the females. The results are due to the appearance of two mutations, one, the ultra-bar, which has been observed on several other occasions and the other a factor which causes a return of the mean to that of the unselected population. While the prevalence of lethal factors in the direct line of the selection stock suggests that the effectiveness of reverse selection may be due to their presence, all the evidence cannot be brought into agreement with such a view.

10. *Genetic mosaics and ontogenetic abnormalities in the parasitic wasp, *Hadrobracon*.* (Charts.) P. W. WHITING, University of Iowa.

Genetic differences are orange eye-color, completely recessive to black and defective venation, irregularly recessive to normal. Normal inheritance is sex-linkoid. Sexes are readily distinguished by antennae, abdominal sclerites, and external genitalia. Patroclinous and mosaic males have all external characters and usually gross internal anatomy normal for male. They are regularly produced in variable percentage from cross of black male by orange female. Much more rarely they arise from black female by orange male, but these have thus far been patroclinous for wing character only. They are usually sterile, but if fertile transmit either paternal or maternal characters. In one case both were transmitted and male bred like a zygote. A single sterile male with orange eyes and black ocelli arose from heterozygous female crossed to black male. Only two

gynandromorphs have been found. One was female except for one-half of the abdomen which was clearly male. The other had anterior half male, posterior female. Mosaic males may be due to failure of nuclear fusion at fertilization. Gynandromorphs arise from mixture of haploid and diploid tissue. The male which bred like a zygote may be tentatively explained as a sort of gynandromorph. Certain variations affecting external genitalia produce what was at first thought to be 'intersexes.' These have now been shown to be accidents of growth not correlated with sex.

11. Olive, a mutation in Colias philodice. JOHN H. GEROULD, Dartmouth College.

Olive-green caterpillar color is recessive to normal grass-green. The eye of the butterfly developed from an olive-green caterpillar is not normal yellow-green, but olive-green. That the recessive gene probably adds to the normal grass-green hemolymph an orange pigment not yet detected in the blood itself, or at least a determiner of such pigment, is demonstrated by the fact that certain wing scales of the mutant butterfly always show a peculiar orange or buff pigmentation, not normal in this species. This orange pigmentation is most marked on the under surface of the hind wings and of the tip of the fore wings, parts most directly exposed during wing development in the pupa to the action of the hemolymph. The orange-producing gene for 'olive,' acting through the blood upon the grass-green pigment derived from chlorophyll and passed on by the blood to the hypodermis of skin (larva) and eye (butterfly), turns this pigment olive-green; the altered hemolymph, acting upon the wing scales, turns them orange. This gene interacts with another recessive factor, viz., that for blue-green blood and caterpillar color, to give a 9:3:4 ratio (9 grass-green, 3 olive-green, 4 blue-green). The delicate purple sheen that appears in the skin of certain blue-green caterpillars (with blue-green blood) probably indicates the presence and action in them of the recessive olive factor. 'Olive' \times 'olive' breeds true, but certain individuals heterozygous for blue-green produce 25 per cent of blue-green caterpillars.

12. Incomplete synapsis of chromosomes and its possible relation to linkage variations. (Lantern.) C. W. METZ, Carnegie Institution of Washington.

In flies of the genus *Dasyllis* certain chromosome pairs appear to undergo incomplete synapsis during spermatogenesis, with the result that certain parts of the chromosomes remain well separated throughout the spermatocyte growth period. The process is uniform and constant in these particular chromosomes, which can be identified by their size and shape. Such chromosome behavior recalls the genetic behavior of the low crossover strains of *Drosophila melanogaster* (Sturtevant, Detlefsen) in which crossing over is greatly reduced or eliminated in certain 'regions' of particular chromosomes. One simple assumption that might account for this result is that of incomplete synapsis in the chromosomes involved. Unfortunately, *Drosophila* is not favorable for a cytological study of this question and *Dasyllis* is unsuitable for genetic analysis, so that the two lines of evidence cannot, as yet, be obtained in the same animal. However, the data from *Dasyllis* leave little doubt on one of the main points, namely, that synapsis is not necessarily uniform but that different parts of a chromosome may differ radically in this respect. This fact lends support also to the hypothesis that the grouping or clumping of genes in the chromosome maps

of *Drosophila* may be due to differences in the intimacy of synapsis in the corresponding regions of the chromosomes.

13. *A cross in guinea-pigs best explained by assuming 75 per cent crossing over.* (Lantern.) HEMAN L. IBSEN, Kansas State Agricultural College.

The factors involved are *P*, dark-eyed, *p*, pink-eyed; *Cr*, non-yellow, *Ca*, albino; *e^p*, tortoise, partial extension of black, *e*, non-extension of black. Two crosses were made: 1) A pink-eyed self-white, *pp ee Cr Cr* was crossed with a 'dark-eyed' albino, *PP ee Ca Ca*, and the dark-eyed self white offspring, *PP ee Cr Ca*, were inbred, producing 120 dark-eyed self whites and 64 which were either albinos or pink-eyed self whites. 2) A pink-eyed self white, *pp ee Cr Cr* was crossed with a 'dark-eyed tortoise' albino, *PP e^p e^p Ca Ca* and the dark-eyed non-yellow tortoises, *Pp e^p e^p Cr Ca*, were inbred, producing 51 dark-eyed non-yellow tortoises 6 pink-eyed non-yellow tortoises (*pp e^p Cr*), 16 dark-eyed self whites (*P ee Cr*) and 38 pink-eyed self whites or albinos.

The first cross was made to determine whether a 9:7 ratio would be obtained in the F_2 , and the second, whether a 27:8:9:19 ratio would be obtained. Neither was closely approximated. However, by assuming that *P* and *Cr* were linked, and that 75 per cent crossing over took place in both sexes, it was found that the theoretical ratio (41 dark-eyed : 23 pink-eyed or albinos) fairly closely approached the observed ratio. If in addition one assumed that *e^p* was not linked to the other two factors, the theoretical ratio for the second cross (123 dark-eyed non-yellow tortoises : 41 dark-eyed self whites : 21 pink-eyed tortoises : 71 pink-eyed whites or albinos) was also found to be fairly close to the observed ratio. This hypothesis is tentative. Final proof can be obtained only by mating the heterozygotes back to recessives.

14. *A linkage diagram of nine factors for color patterns in Apoletix eurycephalus Hancock.* ROBERT K. NABOURS, Kansas Agricultural Experiment Station.

The recessive, gray normal (primitive, or wild type) and nine dominant color characters, all from nature, are as follows: $+/+$ = grey normal; M/M = V-pattern; Y/Y = white-spot; O/O = white-all-over; R/R = yellow-all-over; W/W = yellow-striped-femora; Z/Z = brown-tipped-femora; G/G = brown-stripe; K/K = white-stripe; T/T = red-all-over (American Naturalist, 1919). During the ten years of the experiment, breeding bisexually and parthenogenetically, these factors have been paired 200,942 times in the females, ranging from 15,142 pairings of *R* and *K* to 1,794 of *O* and *W* (crossing over occurs only to a negligible extent in males). *M* and *Y* are nearly, if not exactly, allelomorphs. *O*, *R*, *W* and *Z*, forming a group of multiple allelomorphs, average 5.82 per cent of crossing over with *M* and *Y*, *G*, *K* and *T*, each allelomorphic to the other, average 0.63 per cent of crossing over with the *O*, *R*, *W*, *Z* group. The average direct crossing over between *M* and *Y* and the *G*, *K*, *T* group amounts to 6.12 per cent. The difference between this longer distance and the sum of the two shorter, amounting to 0.33 per cent may partly be accounted for by double crossing over, which infrequently occurs. There are considerable divergences among several pairs in the crossing over percentages, and wide divergences among given pairs between the percentage of linkage, or coming together, and the percentage of separating, or crossing out.

15. *Genetic analysis of low crossover stock, produced by selection.* J. A. DETLEFSEN and L. S. CLEMENTE, University of Illinois.

A stock of *Drosophila melanogaster* produced by selection and giving about 5 to 6 per cent crossing over between red eye and long wing vs. white eye and miniature wing was mated to a stock of white eye, crossveinless, cut-wing, miniature, forked. The results of the F_1 and F_2 show that: 1) One of the two homologous chromosomes alone has been affected, namely, the one carrying red-eye and long-wing. The other chromosome carrying white-eye and miniature-wing was apparently unaffected by selection. 2) The regions from red to cross-veined and from cross-veined to not-cut are about 13 and 7 units long, respectively, but in our low selected series these regions have been very greatly reduced, perhaps to less than one unit. The region from not-cut to long-wing is about 16 units normally, but has been reduced to about one-fourth of this value. The region to the right of long-wing up to not-forked has been slightly reduced in crossover value, although this region was not involved directly in the process of selection. The total distance between red-eye and long-wing is about 33 units normally but in our low series it has been reduced to 5 units, or at least the percentage of crossing-over is about 5 per cent. Comparison of F_1 and F_2 distributions show that the latter are more variable.

16. *Ten years with the self-fertilized line of *Lymnaea columella*, Say.* HAROLD SELLERS COLTON, Zoological Laboratory, University of Pennsylvania.

On the night of February 4, 1911, a pond snail from a tank in the vivarium of the University of Pennsylvania laid a mass of eggs. The young snails hatching from those eggs were isolated from one another and so prevented from mating. Although cross breeding was prevented, yet for forty-seven generations the line has continued to live because the snails self-fertilize their own eggs. Extending over a period of almost ten years inbreeding of the very closest sort has been practiced, resulting in an animal of great theoretical gametic purity; greater perhaps than any other animal which reproduces sexually. This line of snails agrees with the experience of King, Wright, and others, namely, that inbreeding does not appreciably affect the viability of the race.

17. *Results of eight years of inbreeding of Rhode Island Red fowls.* (Lantern.)

L. J. COLE and J. G. HALPIN, University of Wisconsin.

Selection on the basis of a non-vital character (plumage color) resulted in a rapid deterioration of the stock, which ran out completely in four years. Egg production was affected to some extent, but the deterioration was particularly noticeable in vitality, as measured by hatchability of the eggs. In a second phase of the experiment the inbreeding has been of the same intensity, but selection has been based on vigor, as measured by good hatchability and strong vigorous chicks. This has resulted so far in raising the general vitality of the stock, though there appears to have been a loss in egg production, which has not been considered directly in the selections. The results can be interpreted as due to the inheritance of lethal, semilethal or physiological-defective factors, though no such have as yet been experimentally isolated.

18. *Inheritance of color in the domestic turkey.* (Continued.) W. R. B. ROBERTSON, University of Kansas.

In 1920 a black male was bred to a bronze female. The F_1 generation was black except for a few barred feathers among the coverts of the tail. Also a narragansett male was bred to a bourbon red female. The F_1 's were much like the narragansett, but showed distinctly the influence of the red in increased amount of the red or auburn in the feathers. In 1921 an F_1 black (bronze) male was mated to three F_1 Narragansett-red females. In F_2 there were 4 black males and 2 black females (all showing a very few barred-pattern feathers among the tail coverts), 2 rusty black males showing more traces of barring than in the black, 1 bronze male and 6 bronze females, and 4 bronze-red males and 2 bronze-red females. The classes theoretically should be black (narragansett), black-red, bronze (narragansett), and bronze-red. All classes are represented. The small numbers may account for the absence of females in the black-red. The experiment shows that the narragansett pattern is an additional allelomorph. The series is black, bronze, narragansett, and bourbon red. This order also indicates their relative dominance, black being most dominant, bronze next, etc. Bronze seems to be completely dominant to narragansett.

19. *Orthogenesis of non-homochromic pigmentation in chromodorids.* W. J. CROZIER, Rutgers College.

In all species of *Chromodoris* for which color descriptions exist, indication is had of the presence of two distinct types of integumentary pigments. One of these substances has a characteristic band absorption spectrum and other properties permitting ready identification. As obtained from different species (Bermuda, California), this substance is found to be chemically very similar, perhaps identical. Since the habits of the various species are different, the relation of coloration to habit may be interpreted in accord with modern genetic views of adaptation.

20. *Breeding experiments with the viviparous teleosts, Xiphophorus helleri and Platypoecilus maculatus (Günth.).* A. W. BELLAMY, University of Chicago.

The material is admirable for studies pertaining to heredity of physiological and morphological characters; sex-differentiation; and experimental evolution. *X. helleri* is conspicuously marked by a lateral red stripe and other minor color variations. Dorsal fin has 13 ± 1 rays. A ventral prolongation of the caudal ('sword-tail') is characteristic of males. Form-index—body length/greatest depth—3.5 for males; 3.0 for females. *P. maculatus* presents four color varieties: 'rubra,' 'nigra,' 'pulchra,' (spotted), 'plain.' Dorsal fin has 10 ± 1 rays. Form-index for males and females approximates 2.7. In males of both genera the anal fin becomes modified (*X. helleri*, 136 ± 60 days; *P. maculatus*, 141 ± 80 days after birth) to form an intromittent organ. Sex ratios are very erratic, especially in *X. helleri* which averaged (317 fish) 100 males to 67.7 females; *P. maculatus*, (669 fish) 100 males to 147.7 females.

Most of the possible straight, reciprocal, and back-crosses have been made. Only general results from the cross: 'nigra' male and *X. helleri* female can be given here. F_1 hybrids are uniform and deep greenish black much darker than darkest parent. (True of most black hybrids.) One mating gave 8 males, 1

female; another 0 males, 10 females; another 6 males, 0 females. Dorsal fin rays, 11-12. Males have small 'sword'—a male secondary sex character inherited through the female, as Gerschler showed. F_2 : one mating gave variable greenish blacks, males 12; females 30; variable whites, males 30, females 5. Two blacks approximated the 'nigra.' Several white males show the 'sword.' A peculiar type of sex-linked inheritance is indicated in this and other crosses. Most F_1 hybrids are fertile; many F_2 and sesqui-hybrids are sterile. Intersexes occur. Form indices vary from one extreme to the other in both sexes.

21. The elimination of the sex-chromosome by x-rays: A modification of the germ plasm produced by an external agent. JAMES W. MAJOR, Union College.

Homozygous, wild type, virgin female *Drosophila* were treated with x-rays and mated to white-eyed males. None of nineteen control pairs produced any white-eyed flies, although they produced over 6500 offspring. Twelve out of fifteen treated females produced white-eyed males.

22. Hybrid vigor, hybrid weakness, and the chromosome mechanism of heredity.

An experimental analysis of the physiology of heredity in the reciprocal crosses between two closely associated species of sea-urchins, Strongylocentrotus purpuratus and S. Franciscanus. H. H. NEWMAN, University of Chicago.

Much has been written of late about hybrid vigor, in interspecific F_1 hybrids, especially among plants. East and Jones have attempted to explain the added vigor of such hybrids as due to the summation in the hybrid of the dominant or favorable characters of the two species. They imply that all F_1 interspecific hybrids exhibit hybrid vigor. The writer has for a long time called attention to the fact that, in every lot of cross-fertilized eggs, weak and defective individuals are as obvious as are those that show hybrid vigor. In 1908 the writer explained the extra vigor of the surviving *Fundulus* hybrids as the result of the chance combination of the more favorable or dominant specific characters, and the relative lack of vigor of other individuals as the result of less favorable combinations of specific characters.

In Echinoderm hybrids, as in Teleost hybrids, the entire history of large groups of individuals can be followed from fertilization to a definitive larval condition. In the cross, *Strongylocentrotus purpuratus* ♀ × *S. franciscanus* ♂ there is frequently very pronounced hybrid vigor associated with extreme hybridity in many positive larval characters; yet there is also equally prevalent hybrid weakness. In the reciprocal cross there is no hybrid vigor, but only hybrid weakness, and very little, if any, paternal heredity. These facts form the basis of certain theories of heredity that cannot be put forth in an abstract. It is, however, the writer's belief that they are compatible with current theories of the chromosomal mechanism of heredity.

23. Changes in egg production at the Massachusetts Agricultural Experiment Station.

H. D. GOODALE, Massachusetts Agricultural Experiment Station.

A history of the steps taken to date. Egg production has been increased by selection, based on the consideration that at least five major components can be recognized in one egg record, namely, maturity, winter pause, broodiness, intensity, and date of last egg. Thus far, attention has centered on decreasing the average age at which the first egg is laid, the decrease being fifty-eight days, with

corresponding increase in winter production. Broodiness has also been reduced. The mean annual production has been increased from 121 to 185 eggs.

24. *Variations in the number of vertebrae and other segmental characters of fishes correlated with the temperature of the water during development.* CARL L. HUBBS (introduced by L. V. Heilbrunn), Museum of Zoology, University of Michigan.

The writer for a number of years has been studying the correlation between altered environmental conditions and the number of vertebrae and other segmentally arranged structures in fishes. Johannes Schmidt has been carrying on a series of intensive investigations which deal with the same problem, and which are for the greater part rather closely paralleled by the writer's studies. Both of us have obtained, independently, a rather large volume of experimental and observational evidence indicating that the meristic characters displayed by an individual fish are determined not alone by heredity, but in part also by the environmental conditions, notably temperature, which prevail during some sensitive developmental period. We have further demonstrated that altered environmental conditions induce differences highly similar to those which characterize local races in fishes, some of which have been proved genetically distinct. For example, differences induced by cold are in the same direction as those characterizing races inhabiting cold water. The writer is planning a series of investigations by which he hopes to arrive at an explanation of these phenomena.

B. EMBRYOLOGY

1. *Cell behavior in tissue cultures.* (Lantern.) H. B. GOODRICH, Wesleyan University.

1. A non-amoeboid type of cell motion.—A study has been made of a peculiar mode of motion of certain isolated cells observed in tissue cultures of *Fundulus heteroclitus* and *F. majalis*. These cells are identical with those observed by Doctor Dederer (paper in press) and identified as mesenchyme cells. These cells are described as having peculiar fan-like expansions by which they are anchored to the cover-glass. The present observations indicate that these fans form the motor organs of the cell. The motion is apparently not amoeboid. The fan seldom changes in form while in motion and it has the consistency of a colloid gel. It is a delicate membrane which glides on the under surface of the cover-slip and pulls after it the body of the cell. The maximum observed rate of motion was 6 μ per minute.

2. Tactile reactions. Experiments utilizing the micro-dissection needle show that the cell body may be touched by the needle and thus be stimulated to release the fan and to contract. The tactile reactions of the pigment cells have also been studied. The black melanophores, red chromatophores, and yellow chromatophores form a series, in order named, of increasing tactile response (as shown by withdrawal of pseudopodia) to the touch of the micro-dissection needle.

2. *Experiments with *Necturus* and axolotl thyroids.* W. W. SWINGLE, Yale University.

1. Adult *Necturus* were fed large quantities of physiologically active thyroid, anterior lobe pituitary and simultaneously transplanted with frog thyroids. Results negative at the end of four months despite the enormous thyroid dosage.

2. Thyroids of untreated *Necturus* were transplanted into immature *R. clamata* larvae without limbs. Ten to fourteen days later the larvae presented the symptoms of hyperthyroidism, such as fore and hind leg development and practically complete tail atrophy. Despite its larval characters *Necturus* possesses highly active thyroid glands and seems to have lost the ability to transform, under stimulus of thyroid feeding.

3. The thyroids of an axolotl 14.25 inches long and at least four years of age were transplanted into *R. clamata* larvae without limbs. The glands were large, vascular, and the vesicles distended with a fluid, presumably colloid. The glands were cut into six parts and six larvae grafted. One tadpole died two days later, the remainder showed the typical hyperthyroid reaction upon the eighth day. Two weeks from the date of grafting the larvae had fore and hind legs, and showed marked tail resorption. Thus a single axolotl thyroid when extirpated contains enough active hormone practically to metamorphose five tadpoles, but when left unmolested within the axolotl's body is incapable of initiating metamorphosis. Axolotl neoteny is apparently due to the inability of the thyroid gland to excrete into the blood stream its fully formed and physiologically active hormone. A releasing factor is lacking. Axolotls readily metamorphose when fed thyroid in large quantities. The pituitary of axolotl appeared normal; when transplanted, the gland was resorbed and results negative.

3. *Chorionic fusion and augmented twinning in the human tube.* LESLIE B. AREY, Northwestern University Medical School.

The data from all known cases of human tubal twins indicate that the ratio of monochorial to dichorial specimens is about fifteen times greater in the tube than in the uterus. Illustrative stages are at hand which indicate that this disproportion results in part from the secondary fusion of the chorionic sacs of dizygotic individuals. Hence for man the term 'monochorial' need not always connote a single ovum origin. However, a still more potent factor appears to be an actual augmentation of the twinning impulse. Its cause is most clearly referable to tubal inflammation and its sequelae. The same delays and arrests which cause and follow tubal implantation are largely responsible for both the increased twinning and the excessive malformation of tubal specimens.

4. *The influence of thyroid-gland feeding upon tadpoles from which the thyroid gland and the buccal anlage of the hypophysis have been removed.* BENNETT M. ALLEN, University of Kansas.

These experiments were performed upon *Rana sphenoccephala* 1) normal controls; 2) controls cut as for hypophysis removal; 3) thyroidless tadpoles; 4) those deprived of the buccal anlage of the hypophysis, and 5) tadpoles deprived of both thyroid and buccal anlage were fed weighed quantities of sheep-thyroid preparations. The purpose was to determine whether the influence of thyroid feeding would be the same in each case. Tadpoles in young feeding stages were employed in lots of twenty-five. It appeared that the presence or absence of these glands in the tadpoles had little control upon the influence exerted by thyroid feeding upon limb development. The tail was not so quickly reduced as a result of administration of thyroid to groups 4 and 5 as in groups 1, 2, and 3. It is possible that future experiments in administering more diluted doses of thyroid prepara-

tions may prove a more delicate test. A study of the thyroid glands of controls and of tadpoles deprived of the buccal anlage of the hypophysis fails to show any modification of gland development or of colloid accumulation to result from thyroid feeding.

C. CYTOLOGY

1. *A determination of the degree of constancy in the nuclei of certain organs in Hydatina senta.* H. J. VAN CLEAVE, University of Illinois.

Eric Martini ('12) maintained that each individual of *Hydatina senta* bears a fixed total number of 959 nuclei for the entire organism. A. F. Shull ('18), using serial sections, studied the vitellaria and gastric glands of this species to determine a measure of the exactitude of nuclear constancy. In 245 vitellaria he found 4 per cent which did not contain the customary eight nuclei. Over 7 per cent of the gastric glands examined by him displayed numbers of nuclei other than the characteristic six. Age, culture media, and male and female determining strains were considered, but there was no striking difference in the numbers of aberrant glands under different conditions of his observations. Subnormal numbers of nuclei were more frequently encountered than supernumerary and odd numbers were more frequent than even in the variants described by Shull.

An investigation of stained whole mounts, begun by the present writer soon after the appearance of Martini's monograph, has just been completed; 435 gastric glands were examined without discovering a single variant from the customary six nuclei in each. In 770 vitellaria, three were found with supernumerary nuclei, two with ten each and the third with twelve nuclei. Not a single subnormal number was observed nor were there any variants bearing odd numbers. Frequently vitellaria were observed with the number of nuclei normal but with unusual appearance, strongly simulating conditions in amitosis. Every aberrant individual encountered in this study presents evidences of an inconstancy superimposed upon an absolute constancy in nuclear numbers.

2. *Further studies in the cytology of Anisolabis maritima, Bon.* (Lantern.) S. I. KORNHAUSER, Denison University.

It was previously determined that the diploid chromosome number is 25 in the male and 26 in the female. Eleven tetrads and a hexad appear in the primary spermatocyte metaphase plates, whereas in the second spermatocytes half show 12 and half 13 dyads. A detailed study of the hexad was made. It was found to be an XXY complex made up of three distinct spermatogonial chromosomes. Unlike the 22 autosomes these three remain compact during the leptonema. The two X-chromosomes soon come to lie side by side and while the autosomes are conjugating the Y-chromosome approaches and is in contact with the two X-elements by a narrow strand. Parasyndesis of the autosomes being completed the Y-element now separates and remains apart from the XX-element during the zygonema and pachynema. The X-elements stain like chromatin, but the Y-element is lighter in chromatin stains, is vacuolated and after Benda fixation takes mitochondrial stains.

With the onset of the strepsinema XX and Y-elements fuse, and soon give off a spherule which stains like mitochondria and which gradually diminishes in size and disappears before the first meiotic spindle is formed. The XXY-hexad

comes out of the fused mass. From now on the Y-element reacts to stains exactly like chromatin. In the first meiotic division 11 autosomal dyads and the XX-element pass to one pole whereas 11 autosomal dyads and the Y-element pass to the opposite pole. During the interkinesis the two components of the XX-element separate so that half the second meiotic division plates show 13 dyads.

3. *The occurrence of telosynapsis in the male germ cells of Leptocoris trivitattus, Say.* (Hemiptera). HARRY B. YOCOM, University of Oregon.

In *Leptocoris trivitattus*, Say, the chromosome complex of the spermatogonium consists of thirteen chromosomes, ten autosomes, two 'M' chromosomes, and one accessory chromosome. After the last spermatogonial division all of the chromosomes except the accessory enter into a fine spireme which is tightly tangled toward the center of the nucleus. As growth of the primary spermatocyte proceeds this thread becomes thicker and unwinds, so that it fills the nucleus with a loosely convoluted thread. Near the end of the growth period this thread again contracts into a mass concentrated toward the center of the nucleus. There is no indication of any polarization or pairing of the thread during this period of synizesis. Later this spireme spreads out until it fills the nucleus with a lightly staining very diffuse work, the organization of which it was impossible to determine. The chromatin of this diffuse mass becomes condensed into a number of masses, probably twelve, which as they become compact unite end to end to form the bivalent chromosomes of the primary spermatocyte. Conjugation of the homologous chromosomes is therefore by telosynapsis. The accessory chromosome can be distinguished at all times during the growth of the spermatocyte by its compactness and rounded contour. At the first spermatocyte division which separates the homologous chromosomes, the accessory chromosome divides equally. At the second maturation division the accessory passes to one pole undivided.

4. *Studies on the cells of sheep with special reference to spermatogenesis, oögenesis, and sex-determination.* (Lantern.) J. E. WODSEDALEK, University of Idaho.

Thirty-three chromosomes occur in the spermatogonia. One, the sex-chromosome, is distinctly larger than the others. Seventeen chromosomes appear in the primary spermatocyte division, of which sixteen are bivalent and the other is the unpaired sex-chromosome. This division gives rise to two types of secondary spermatocytes since the sex-chromosome passes to one pole undivided. Finally two types of spermatids are produced. All of the spermatids contain the sixteen autosomes while only half of them possess the additional sex-chromosome. Thirty-four chromosomes occur in the oögonia; two of these are the sex-chromosomes. Seventeen bivalent chromosomes appear in the primary oöcyte division; one of these, clearly the largest, is the bivalent sex-chromosome. The reduced number of chromosomes in the female is sixteen autosomes and one sex-chromosome, the same number being thrown off with the first polar body. This takes place in the ovary while the oöcyte lies in the graafian follicle. Various stages of this process have been observed in a number of cases. The prevailing number of chromosomes in the somatic cells of male embryos and foetuses corresponds to the number present in the spermatogonia. While the number in the somatic cells of the female corresponds to the number present in the oögonia.

5. *The structure and division of Trichomonas augusta alexzeieff.* D. H. WENRICH, University of Pennsylvania.

This flagellate, found in the rectum of many Amphibia, possesses the organelles characteristic of the genus: nucleus; cytostome; and the blepharoplast to which are attached a group consisting of three anterior free flagella, a posterior flagellum which is also the chromatic margin of the undulating membrane, the chromatic basal rod, the parabasal body and the axostyle. As in *Trichomonas muris*, the parabasal body appears only after certain fixatives such as weak Flemming's. The undulating membrane contains near the chromatic margin a secondary filament of small caliber. This is well shown after fixation with Bouin's fluid. During the prophase of division the nuclear chromatin gradually organizes into double (split?) chromosomes and a small new chromatic basal rod appears, attached to the blepharoplast. Later this rod is seen to be accompanied by a small new undulating membrane. The blepharoplast divides, the daughters separating but remaining connected by the chromatic paradesmose. In the metaphase plate seven double (split?) chromosomes can be counted which at first have their long axes perpendicular to the spindle axis but during separation become elongated parallel to the spindle axis. The axostyle becomes detached from the blepharoplast and gradually disintegrates. During the telophase the daughter nuclei become organized and a new axostyle grows out from each daughter blepharoplast. Excepting the blepharoplasts and nuclei, the new organelles needed to complete two sets appear to develop anew. When two complete sets of organelles have developed, the cell body divides.

6. *Multinucleated germ cells in the Columbian ground-squirrel.* (Lantern.) J. E. WODSEDALEK, University of Idaho.

Cells containing two or four nuclei were rarely found by the writer in his studies on the male germ cells of swine, horses, cattle, and sheep, and a few cells with eight nuclei were observed in the cat. Multinucleated cells are much more numerous in the testes of the Columbian ground-squirrel (*Citellus columbianus columbianus*). Cells with two, four, and eight nuclei were occasionally found in the tissue taken from eighteen individuals. In the tissue taken from two individuals not only are the cells containing two, four, and eight nuclei plentiful, but cells with as many as sixteen and thirty-two nuclei, of the spermatid type, are fairly common. The two males concerned were vigorous specimens and their germ cells were extremely active. Numerous mature spermatozoa and others in the process of development were present. Other normal cells in the various stages of mitosis were also abundant in the immediate neighborhood of the multinucleated cells.

7. *Seasonal changes in the testis of Gambusia affinis, the top-minnow.* S. W. GEISER (introduced by S. O. Mast). The Johns Hopkins University.

The testes develop from the typical anlage. During early life, they are separate, except at their posterior ends; at the age of two to three months, they fuse more or less completely along the median line. The testis consists of fine connective-tissue stroma which becomes apparent as investments of the cysts when the testis is in active spermatogenesis. In adults the longitudinal testicular canal (vas deferens of German workers) is tubular, tortuous, usually paired,

but sometimes fused. Testes fluctuate in volume between summer and winter, but the fluctuation is not very marked (eight-fold volume-increase in summer, maximum found). Testes in Winter are filled with spermatzeugmata, which greatly swell the 'vas deferens,' so that it sometimes comprises 62.4 per cent of the volume of the testis, as compared with 1.2 per cent to 1.5 per cent at the high-point of spermatogenesis (May/June.) The testis does not possess cords of sex-cells for the renewal of the testis after spermatogenesis. There are no spermatogenic tubules. The spermatogonia develop apparently from inconspicuous germ-cells lying in the stroma of the testis, between the cysts. These cells migrate peripherally (outside the zone of the vas deferens) and give rise to new spermatogonial cysts. The period of greatest sexual activity (max. testis-volume) in early spermatogenesis is March/July. The onset of this period appears to be largely conditioned by temperature and light conditions. In November/February, the testes attain their minimum size. With the onset of cold weather, sexual activity ceases. No spermatogenesis occurs during the cold weather.

All the cells in a spermatogonial cyst are in approximately the same stage of spermatogenesis. A spermatzeugma may have from 5000 to 13000 spermatozoa.

8. *Changes in the vaginal epithelium of the guinea-pig during the oestrous cycle.*

R. M. SELLE (introduced by J. A. Long).

The oestrous cycle in the guinea-pig shows four clearly defined periods or stages, in addition to the interval, which correspond to similar stages in the rat. In the first stage, which apparently was overlooked by Stockard and Papanicolaou, the vaginal smear contains large, vacuolated, granular epithelial cells only. These epithelial cells are derived from the superficial layers of the mucosa beneath which cornification has been going on. The mucosa is highest at this time. In stage 2 the superficial epithelial cells are gone, leaving uppermost the cornified stratum. The latter by scaling off furnishes the typical, non-nucleated, flake-like cells of the smear. Up to this point the similarities of the rat are close. However, in the guinea-pig the whole cornified layer, not the whole epithelium, with some of the underlying non-cornified epithelial cells may be shed en masse like a cast. Whereas in stage 3 in the rat the granular, cheesy material consists of the elements of the cornified stratum, rapidly desquamated singly or in small groups until the stratum is entirely lost, in the guinea-pig the cheesy mass described by Stockard and Papanicolaou is constituted of the deeper-lying non-cornified epithelial cells which are shed in large numbers. In the last stage (4) leucocytes appear as described by Stockard and Papanicolaou in their stage 3. No state has been found corresponding to their 4. There is no evidence of any important contribution by the uterus to the cellular contents of the vagina, for the latter is practically identical in normal pigs and in hysterectomized pigs.

D. COMPARATIVE ANATOMY

1. *Metamorphic changes in the digestive system in Rana pipiens and Amblystoma tigrinum.* ALBERT KUNTZ, St. Louis University School of Medicine.

The period of metamorphosis and the coincident period of fasting occupies approximately ten days in *Rana pipiens* and nine days or less in *Amblystoma tigrinum*. Quantitative data at hand indicates the following changes during metamorphosis.

	B. PIPIENS	A. TIGRINUM
	per cent	per cent
Average reduction in total weight.....	57.3	28.7
Average reduction in length of stomach and intestine.....	82.2	45.8
Average reduction in length of stomach.....	54.5	54.8
Average reduction in weight of stomach and intestine with contents.....	92.8	68.6
Average reduction in weight of liver.....	80	None

The more important histological changes in the stomach and intestine during metamorphosis consist in increasing thickness of the several layers and more compact aggregation of the tissue elements as the reduction in the length of the digestive tube takes place. The increase in the thickness of the several layers does not involve active cell proliferation, but is accomplished by rearrangement and aggregation of the elements already present. These histological findings agree essentially with those of Ratner ('91) in *Rana temporaria*.

2. *The skull of Syngnathus fuscus.* JAMES E. KINDRED, Western Reserve University.

In an earlier paper the primary stages in the development of the skull of *Syngnathus fuscus* were discussed and certain fundamental characters of importance were described and commented upon. That study has been followed by a comparative study of the ossification processes leading to the formation of the adult skull. The material has been described with reference to the modifications which the skull of *Syngnathus* shows when compared with a closely allied form as *Gasterosteus*. In its development, the skull of *Syngnathus fuscus* (pipe-fish) shows certain important differences from the skulls of related forms. The elongate condition characteristic of the skull of the adult fish is arrived at very early in life through the precocious growth of the ethmoid and symplectic cartilages. As a result of this the mandibular apparatus has been carried to the end of the snout and a series of bones developed for the support of the walls of the oral tube. These bones are arranged in such a manner that they form a flexible wall for the tube. They have been homologized with the suborbitals and nasal bones of closely allied species, but in this study I have regarded them as independent elements which are developed in response to local needs and not as modifications of the above bones of other teleosts. Various modifications from ordinary teleostean type of skull have been observed and a detailed description and comparison of the components of the skull has been made and the points wherein this fish is primitive or specialized have been discussed.

3. *The thyroid glands of perennibranchiate amphibians.* W. W. SWINGLE, Yale University.

The thyroid glands of *Necturus* are situated beneath the mylohyoid muscle, at the apex of the triangle formed by the geniohyoid and external cerato-hyoid

muscle. The glands are quite small but are perfectly formed and contain much colloid. In some animals the glands vary in size and location, the vesicles may be few in number but very large. Through the courtesy of Prof. Stejneger of the United States National Museum a specimen of *Typhlomolge rathbuni* was obtained. The animal had been preserved in alcohol for eighteen years. The thyroids could not be located, though vesicular structures filled with fluid and resembling the glands were first mistaken for them. Further investigation of two additional specimens of *Typhlomolge* failed to reveal glandular tissue. The thyroid apparatus of *Proteus* has been described by Franz Leydig, 1853 (*Anatomisch-physiologische Untersuchungen über Fische und Reptilien*, p. 62), and appears not to differ from the condition described for *Necturus*. The thyroids of tadpoles with extraordinarily prolonged larval lives, such as *R. clamata* and *R. catesbeiana* have a meager blood supply compared with adult urodeles such as *Diemictylus*, *Amblystoma*, and oddly enough, *Axolotl*.

4. *On the muscular system of Ornithodoros moubata*, Murray. E. MELVILLE DU PORTE, Macdonald College, McGill University.

1. A descriptive study of the musculature of this argasid tick. 2. The introduction of a nomenclature similar to that in use by insect anatomists. 3. An attempt to work out the homologies of the muscles.

5. *On the structure and development of a fat body or gland in the rat*. J. A. LONG, University of California.

This body hitherto undescribed for the rat is of considerable size and is lobed or branched. The main portion, somewhat butterfly-shaped in dorsal aspect, lies in a depression of the muscles in the middorsal line between the shoulder-blades. Continuous with the central part or separated from it only by very short spaces are other plate-like parts extending laterally between the layers of muscles. Some run well down between the deep muscles under the scapulae. It is well supplied with blood and is closely associated with vessels going to the body muscles. It is unlike ordinary body fat in color and structure, being brown to salmon colored, and being composed of cells gorged with droplets of lipid of varying size, among which the spherical nucleus is embedded. The lipid is a neutral fat, staining red in Nile-blue-sulphate. This body is first visible in the embryo of seventeen days, after muscle formation has already begun. It increases so rapidly in size that by the end of pregnancy it is not much less in volume than the liver. The general form and arrangement of the various parts is substantially as in the adult. One detached portion extends as far ventrally as the submaxillary salivary gland. It is very highly vascular; each cell has a spherical nucleus and most cells contain one to several lipid globules of variable size; the whole structure reminding one of an organ of internal secretion such as a corpus luteum.

6. *Relation of growth to metamorphosis in the lungless salamander, Eurycea bislineata.* INEZ WHIPPLE WILDER, Smith College.

For uniformity the material used has been taken from one locality. Hatching occurs during late June and early July. Metamorphic individuals are found throughout the year and range from 42 to 76 mm. in length and from 390 to 1085 mg. in weight. Total length frequency graphs based on representative collections at frequent intervals for seven years involving over 2000 individuals show, 1) large variability in different years; 2) an average length of larval life of two years with a range from one to three years; 3) segregation during the first year into a lagging and a precocious group. Experimental study of growth and metamorphosis under laboratory conditions simulating normal food and temperature conditions show, in addition to corroboration of the above conclusions, 1) successive periods of slow and rapid growth; 2) wide variation, in which sex is not the main factor, in growth and metamorphosis of individuals of the same age under the same food and temperature conditions; 3) possibility of prolonging, through the variation of food and temperature, any of the four developmental periods, postembryonic, typical larval, premetamorphic, and metamorphic. Normal tables of total lengths, tail length indices, weights, weight indices, and developmental stages have been constructed based on representative collections approximately uniformly distributed throughout five years. An exact knowledge of the normal range of variation in rate of growth and development of any species seems absolutely necessary as a basis for correct interpretation of the results of any experimental work on the ductless glands.

7. *Degeneration in the pelvis of the female pocket-gopher, Geomys bursarius.* FREDERICK L. HISAW (introduced by J. E. Ackert), Kansas State Agricultural College.

An examination of over three hundred pocket-gophers collected in the vicinity of Manhattan, Kansas, showed that in the mature animals the pelvic bones are completely ossified and meet to form the pubic symphysis. In both males and females the pelvic girdles are greatly reduced in size. This reduction is obviously an adaptation to their fossorial habit, but, as a result, the puboischiatic-vacuity is too small for the birth of young. However, during the breeding season, a degeneration of the pelvic bones of the young female begins in the pubic region, and continues laterally almost to the obturator foramen. After the birth of young, the symphysis is not reformed, and virgins and old females can be distinguished in this way. Females with abnormal reproductive systems, due to abnormal development or to unnatural confinement in cages, retain the closed symphysis. The degeneration in the pelvis seems to be due to internal secretions of the reproductive system, either before or during pregnancy.

E. ECOLOGY AND ZOOGEOGRAPHY

1. *Chemical composition of some fresh-water organisms.* C. JUDAY, University of Wisconsin and Wisconsin Geological and Natural History Survey.

A number of fresh-water organisms have been subjected to chemical analysis in order to obtain some idea of their food value. The plants included several species of algae and a few of the large aquatics. The animals were represented

by several species of plankton crustacea, crayfish, worms, leeches, insects and insect larvae. Crude protein constituted more than 50 per cent of the dry weight of the plankton algae, but it fell to 10 per cent to 20 per cent in the large aquatic plants. In the animals the crude protein constituted from 36 per cent to 64 per cent of the dry weight of the plankton crustacea and from 35 per cent to 69 per cent in the larger forms, the maximum percentage being noted in the leeches.

The various samples of plant material yielded relatively small percentages of ether extract, only two slightly exceeding 5 per cent, except the diatoms which gave a little more than 13 per cent. The plankton crustacea yielded from 3 per cent to approximately 40 per cent of ether extract, and the larger animals from 3 per cent to 37 per cent. The plant material contained from 2 per cent to more than 10 per cent of pentosans, but all of the animal samples gave less than 2 per cent except a cladoceran, *Holopedium*, which yielded more than 6 per cent. In the plankton algae the ash constituted from 4 per cent to 8 per cent of the dry weight except in the diatoms where it was approximately 40 per cent; the ash amounted to about 25 per cent in the large aquatic plants. In the plankton crustacea the ash varied from about 4 per cent to almost 26 per cent, while in the larger animals it ranged from about 2 per cent in the gyrenids to nearly 35 per cent in the crayfish.

2. *Some adaptations of mayfly nymphs to swift streams.* (Lantern.) G. S. DODDS and F. L. HISAW, West Virginia University.

Animals inhabiting standing water have the problem of locomotion in search and pursuit of food and flight from enemies. At will they may rest, floating in the water or resting upon the bottom. In swiftly flowing water there is no opportunity for rest—the problem of retention of position is a continuous one. Many groups of animals have invaded swift streams and successfully met its problems. Fifteen species of mayfly nymphs from ponds and streams in mountains of Colorado well illustrate modes of adaptation to such conditions. The following ways of meeting the difficult problem of retention of position in rapidly flowing water have been observed. 1) Swimming species of fish-like (stream line) form swim well in still water and the stronger swimmers invade the less swift portions of streams. 2) Species of fish-like form of small size have developed strong legs with which they cling to rocks in the swiftest parts of torrential streams. 3) Flattened forms retain position by: a) avoiding direct shock of water; b) flattening of head and legs in such an attitude that the force of the water presses the animal against the substratum; c) development of sucking organs from gills or ventral surface of abdomen; d) development of strong legs; e) avoiding current in crevices.

3. *Some physical factors related to the distribution of littoral invertebrates.* W. C. ALLEE, University of Chicago.

In addition to considering the direct effects of types of bottoms, shores, plants, and currents, this study deals with the possible correlation of salinity, PH, oxygen content and temperature with the distribution of associations of littoral invertebrates in the Woods Hole region. Two series of associations were studied: those of the flats and those of the rocks. In both the salinity regularly increased as one approached open water. Salinity served as a limiting factor particularly in

the associations placed well back on the flats. Next to salinity the pH of the water varies more regularly with the associations than any other factor examined. Temperature and oxygen did not vary so directly. Temperature serves as a limiting factor in low-tide pools and on the exposed flats; free oxygen vanishes from regions with muck bottom and its absence affects distribution in these places. An index figure based on a combination of these four characteristics is found to vary directly with the associations as one passes from open water. Great caution should be used in stressing any one environmental factor in ecological studies. If, on account of lack of time, it becomes necessary to resort to a single environmental factor index in the study of the distribution of animal associations of the seashore, the character of the bottom, the most obvious and longest-used index, is still the least treacherous.

4. *Ecology of parasites of lake fishes.* A. S. PEARSE, University of Wisconsin.

Statistical studies of fish parasites were made in five Wisconsin lakes: Pepin, Geneva, Green, Mendota, Michigan. The following factors appear to increase parasitism in fishes: wide range and variety of habitats, great variety of food, vegetation, shallow water. According to their degree of parasitic infection the fishes studied in two or more lakes rank as follows: dogfish, smallmouth black bass, white bass, rock bass, pumpkinseed, sucker, black bullhead, bluegill, ciscoes, largemouth black bass, pickerel, carp, buffalo, log perch, blunt-nosed minnow, top-minnow, yellow perch, shiner (*Notropis heterodon*), johnny darter, black crappie, shiner (*N. atherinoides*), bream, shiner (*N. hudsonius*).

5. *The eggs of the frogs, tree frogs and toads of Okefinokee Swamp, Georgia.* A. H. WRIGHT, Cornell University.

In the interior of the Okefinokee Swamp are eleven species of Salientia, and on its edges are seven other species. Those within are *Rana clamitans*, *R. grylio*, *R. sphenoccephala*, *Bufo quercicus*, *B. terrestris*, *Hyla cinerea*, *H. femoralis*, *H. gratiosa*, *Acris gryllus*, *Pseudacris ocularis*, and *Gastrophryne carolinensis*. Those outside are *Rana aesopus*, *R. catesbeiana*, *R. virgatipes*, *Hyla aquirella*, *H. versicolor*, *Pseudacris* sp., and *Scaphiopus holbrookii*.

The eggs of *R. catesbeiana*, *R. clamitans*, *R. grylio*, *Hyla cinerea*, *H. femoralis*, *H. versicolor*, and *Gastrophryne carolinensis* float on the surface of the water; the eggs of *Hyla gratiosa*, *Acris gryllus*, and *Pseudacris ocularis* are laid singly on the various bottoms of the swamp; the eggs of *Bufo terrestris*, like those of *B. americanus*, are in a single file, not double as in *B. fowleri*, while those of *B. quercicus* are isolated single files of five to seven eggs or with several such files about one focus. The eggs of *Scaphiopus holbrookii* are in bands and those of *R. sphenoccephala* are in a plinth mass like *R. pipiens*. The eggs of *Rana aesopus*, *R. virgatipes*, *Hyla squirella*, and *Pseudacris* sp. are not sufficiently identified to allow of positive statement. Eggs laid in captivity by pairs captured at night check the identifications of fourteen species. The first species to breed begin in February or March and each species after it has begun continues oviposition after each rainy spell until September or possibly later.

6. *Further studies on the circulation of water in the Bay of Fundy and the Gulf of Maine.* JAMES W. MAVOR, Union College.

Further studies with drift bottles and hydrographic measurements have confirmed the circulation of water as previously worked out.

7. *The effect of temperature in limiting the geographical range of invertebrates of the Woods Hole littoral.* W. C. ALLEE, University of Chicago.

An analysis of the geographical distribution of 241 species taken in collecting operations in the Woods Hole littoral in the last nine summers shows that 55 per cent are south-ranging and 30 per cent are north-ranging species. 40 per cent of the species are not recorded from north of Cape Cod, while 11 per cent are unknown south of the Woods Hole region. This means that the Woods Hole region is located near the northern end of a south-ranging fauna. The winter temperatures of the last four years display marked variation. Those of 1917-18 and 1919-20 were unusually severe, while the alternate years of 1918-19 and 1920-21 were unusually mild. The effect of this variation in winter temperatures on animal distribution should be most marked near the limits of distribution. The unusually cold winter of 1917-18 caused 38 per cent of all the south-ranging species to be present in noticeably fewer numbers the following summer. Of the south-ranging species whose recorded northern limit is Cape Cod, 48 per cent were affected. The similarly cold winter of 1919-20 was followed by an increase of north-ranging forms. The southern extension of north-ranging species is limited by the high summer temperatures of the flats, just as in shallow water the extreme winter cold limits the northward extension of south-ranging species.

8. *Hydrogen-ion concentration of Chesapeake Bay water.* R. P. COWLES and A. M. SCHWITALLA, S. J. (introduced by S. O. Mast), The Johns Hopkins University.

During the early part of June, 1921, while engaged in a biological and hydrographic survey of Chesapeake Bay for the U. S. Bureau of Fisheries, an attempt was made to determine the hydrogen-ion concentration of the bay water in order to see if it bore any constant relation to the distribution of plankton and living organisms in general. One of the stations selected was a 'deep hole' (40.2 meters) a short distance north of the mouth of the Potomac River, where water samples were taken at one and a half hour intervals for twenty-four hours. By colorimetric methods it was found that there was a decrease in the pH value passing from the surface downward; in other words, that the water became more acid. In general a diurnal change in the pH values at all depths was evident; these values as a rule decreasing during the later part of the night and the early morning when chlorophyll-bearing plants no longer carry on photosynthesis. These observations support the results of McClendon for the sea-water at Tortugas and are confirmed in a general way by observations at another twenty-four hour station. Tidal changes were recorded by means of a current meter at all depths almost simultaneously with the pH observations and there seemed to be a tendency towards a rise in pH value when the tides turned in the daytime.

9. *Canuella canadensis* and other Canadian copepod records. A. WILLEY (introduced by A. G. Huntsman), McGill University.

The paper contains the results of the author's observations on the subjects indicated during a number of years, including notes on distribution and ecology.

F. GENERAL ZOÖLOGY

1. *Note on the rate of growth of teredo and xylotrya.* (Lantern.) THURLOW C. NELSON, Rutgers College and the New Jersey State Board of Shellfisheries.

A platform of dry cypress slats covered with oyster shells was submerged in Barnegat Bay, July 3, 1921, was removed to tidal creek July 25th, and on August 15th collapsed owing to heavy invasion of *Teredo navalis* and *Xylotrya fimbriata*. Slats 2X1 inch contained in cross-section 1 cm. wide, 77 *Teredo* and 3 *Xylotrya*. Average size of *Teredo*: length 15.5 mm., width of body, 2 mm., width at shells, 2.5 mm. Average for *Xylotrya*: length 29 mm., width of body 3.2 mm., width at shells, 4 mm. Maximum number of segments in pallets 14; minimum 5. Upper Barnegat Bay is rarely troubled with 'shipworms.' Abnormal salinity of water resulting from reduced rainfall; water of high salinity creeping up the bay along bottom. Densities of 10082 at surface with 10170 at bottom, 6 ft., were observed. Average density at bottom by platform in bay; 10145, maximum 10170, minimum 10125. Average temperature 25.4°C., maximum 26.6°C., minimum 24.5°C. Average density at surface during same period; 10111, maximum 10117, minimum 10105. During period in creek maximum density 10125, minimum 1009; maximum temperature 30.5°C., minimum 21°C. Ripe eggs present in both species, growth and development must have occurred in less than six weeks.

2. *Observations on sex in the top-minnow, Gambusia affinis.* S. W. GEISER (introduced by S. O. Mast), Johns Hopkins University.

Field collections of *Gambusia* and of other viviparous poeciliid teleosts almost invariably show a great preponderance of females. Experiments with litters of *Gambusia* raised in aquaria, with low mortality-rates, show the proportions of the sexes at birth to be approximately equal. The adult males have a higher death-rate than the females, thus producing a minority of males in adult populations. The gonads of the sexes at birth are indistinguishable from each other. They differentiate at ages of three weeks to over a year, depending upon environmental conditions. Temperature and food largely determine the rate of development. In my experimental litters, all gonads were differentiated in less than four weeks, so that ascertainment of sex was possible. Cytological study shows a fairly close correspondence between the degrees of differentiation and of the development of the anal fin (in the male) into an 'intromittent' or copulatory organ (gonopod). With favorable environment, the gonopod is developed in 95 per cent of the individuals within the first three months, but this development may be delayed till the fish is over a year old. The males in early stages (first 1½ to 2 months) grow in length and weight faster than the females. Total length in both sexes is trebled to quadrupled in the first three months. Females born in May/June bear their first litters of young when 8 to 10 weeks old. The chromosomes in soma and germ-cells are exceedingly small. Their spermatogonial number appears to be 36.

G. PROTOZOÖLOGY

1. *Trophic and reproductive chromatin in the ciliate infuseria compared with similar conditions in other protozoa.* M. M. METCALF.

Euciliata have a trophic macronucleus and a genetic micronucleus. The Protociliata have in each nucleus a double series of chromosomes, one set genetic, the other trophic. In the Plasmodroma we often find two sets of chromosomes, one set introcentrosomal (genetic?), the other set extra-centrosomal (trophic?). Illustration and discussion of these conditions.

2. *Some effects of conjugation in the life-history of Spathidium spathula.* LORANDE LOSS WOODRUFF and HOPE SPENCER, Yale University.

A study has been made of about sixty lines of exconjugants, all derived from a pedigree culture of *Spathidium* and bred under identical cultural conditions. A comparison of the division rate and longevity of the parent lines and their exconjugant lines gave the following chief results. 1) A large majority of the exconjugant lines exhibited a higher division rate than their parent lines. 2) A large majority of the exconjugant lines continued to live after the death of the parent lines. 3) From the original parent cell to the F_4 generation there have been nearly 1000 cell divisions, punctuated at the 30th, 134th, 425th, 573rd, 644th, and 904th divisions by fertilization. The survival value of conjugation is indicated by the fact that the parent, F_1 , F_2 , F_3 , F_4 , and F_5 generations have died in turn—the pedigree culture now existing in the F_6 generation.

H. PARASITOLOGY

1. *The parasitic Protozoa of Blatta orientalis and their value as the material for use in a class of parasitic Protozoa.* R. KUDO, University of Illinois.

One of the difficulties connected with the study of parasitic Protozoa lies in the collection of host animals. Artificial infection and cultivation of parasitic Protozoa have only been done in a comparatively few cases. At present one must obtain a great majority of parasitic Protozoa from their natural sources—the host animals. The occurrence of parasitic Protozoa is highly uncertain. Ordinarily a host species does not harbor many species of Protozoa and the per cent of infection is usually small under natural conditions. For their study, especially in a class-room, one has to collect many individuals of the host animals. The material desirable for a class work should at least fill the following conditions: a) the host animal should harbor Protozoa of variety and large dimensions; b) the per cent of infection should be high; c) the host animal should easily be collected and kept alive in the laboratory; d) the host animal should be of convenient size. After comparative studies of various animals as the host, I came to the conclusion that *Blatta orientalis* is so far best fitted for the purpose and recommend it as the material for class work. The insects examined by me at Urbana, Illinois, harbored the following species of Protozoa: *Endamoeba blattae*, *Lophomonas blattarum*, *L. striata*, *Coelosporidium periplanetae*, *Gregarina blattarum*, *Nyctotherus ovalis*. The papers of pioneer Protozoologists (Stein, Bütschli, Leidy, etc.) and of modern workers (Janicki, Mercier, etc.) upon these Protozoa will be reviewed elsewhere with my own observations upon them.

2. *A preliminary report on the activities of infective hookworm larvae in the soil.*

WILLIAM W. CORT and DONALD L. AUGUSTINE, Johns Hopkins University.

Little is known of the activities of infective hookworm larvae in their natural environment on account of the difficulty of studying them in the soil. An apparatus invented by Baermann, which has made it possible to isolate hookworm larvae from considerable quantities of soil, was used in investigations, which were carried on during the past summer in Trinidad, British West Indies. It was found that a large percentage of infective hookworm larvae isolated from soil samples taken in the field and from laboratory experiments had lost their protective sheaths, indicating that it is a very common thing for them to complete their second moult in the soil and to continue to live unsheathed. Both field studies and laboratory experiments showed that hookworm larvae do not migrate to any extent in the soil, so that soil infestation is practically limited to the places of development. It was also learned that the life of the infective hookworm larvae in the soil is much shorter than is usually supposed. In less than six weeks after the elimination of soil pollution from a cane field, the hookworm larvae present in the soil had almost died out. A series of laboratory experiments showed the same shortness of life even under the most favorable conditions. In these experiments even in three weeks there would be a considerable reduction in numbers and almost none of the larvae survived after six weeks.

3. *Notes on North American blood flukes.* G. A. MACCALLUM, Baltimore.

These interesting trematodes are comparatively new to science. Probably the first found in America were on January 4, 1912, when I found three small worms in the washings of the intestines of a *Chelopus insculptus* and which I named *Spirorchis*, but carelessly omitted the specific name which I intended to be *eustreptos*, both names meaning twisted or spiral, referring to the testis. Again on January 4, 1917, several more of the same were found, and shortly after a species was found in the intestines of *Chrysemys picta*, and these were named *S. pictae*, and what seemed odd some of *S. eustreptos* were also found in the intestines of *Chrysemys picta*, apparently the same worms as those found in *Chelopus insculptus*. Again on August 4, 1921, a specimen was taken from the lung of *Emys blandingii* quite different but of the same genus shown in *Zoopathologica*, vol. 1 no. 6. It is somewhat imperfect, but recognizable. Then on July 17, 1921, I found within the heart of a *Chelydra serpentina* (western form) five *Spirorchidae* which were attached to the wall of the ventricle, but all coiled together as if in coition. These worms were the largest of any *Spirorchidae* I had seen, being in length 8.50 to 9 mm. \times 1 mm. wide, and which I have named *S. chelydrae*. The peculiarity about these worms is the much bent oesophagus, also the numerous glands at the junction of the oesophagus and coeca and possibly posterior also on the outside of the oesophagus to the mouth. These glands probably secrete a sort of hirudin which acts as an anticoagulant for their food.

4. *A study of diphylobothrium ova.* MEYER WIGDOR.

Magath ('19), on the basis of the measurements of 100 ova of *D. latum* and on a peculiar minute thickening of the shell at the pole opposite to the operculum, states: "With these characteristics, which are purely morphologic, one may make a very definite diagnosis of the presence of this worm, the egg lying within the

range of size given above." Measurements of 25 eggs of *D. latum*, *D. fuscum* and *D. pseudocardatum*, a new undescribed species, were made by me and the egg measurements of *D. cordatum* compared. The peculiar shell thickening described by Magath was noticeable in the three species in which eggs were available, so that this morphological feature is apparently a generic rather than a specific one. The ova of *D. latum* in man as given by Magath have an average ratio of length to width of 138:100. My measurements of the ova of *D. latum* and *D. fuscum* in the dog show ratios of 137:100 and 135:100, respectively. As far as the morphological characteristics and the size of the egg of the two species are concerned, *D. latum* and *D. fuscum* in dogs cannot be readily distinguished. The ova of *D. cordatum* and *D. pseudocardatum* are more elongated and relatively narrower than the preceding two species and can usually be differentiated from those two species if an average of several measurements is taken. There is a marked variation in the size and shape of the eggs, however, so that the largest egg of *D. latum* and *D. fuscum* can hardly be differentiated from the smallest eggs of *D. pseudocardatum*. *Diphyllbothrium* ova afford a generic, but hardly a specific differentiation.

5. *A new genus of trematodes from the white-bass.* H. J. VAN CLEAVE, University of Illinois.

A heavy and general infestation by minute distomid trematodes was discovered in the intestine of the white bass (*Roccus chrysops*) from the Mississippi River during an investigation of fish parasites for the Bureau of Fisheries. These trematodes belong to a new genus to which the name *Allacanthochasmus* has been ascribed and for which *A. varius*, the only certain species, is designated as type. *Distomum tenue* of Linton seems to have many points of structure in common with this new genus. Individual variation is very marked in this new species. Relative position of organs such as the testes are greatly modified by the degree of contraction or extension of the body. The oral sucker is surrounded by a prominent crown of spines arranged in a complete single circle. *Allacanthochasmus* seems to have definite relationships with the genus *Acanthochasmus* of Looss and may have considerable phylogenetic significance. Members of this genus display marked host specificity for extensive investigations of the parasites of other fishes, from the same localities where infestation of *Roccus chrysops* were general, failed to disclose a single instance of infestation in any species other than the type host.

6. *Apparent racial immunity to certain nematode infections.* BENJAMIN SCHWARTZ and MARCOS A. TUBANGUI, University of the Philippines.

In the course of a survey on the frequency of helminthic infections in man in the Philippine Islands that is still in progress, it has been found that while the percentage of infestation with certain common intestinal nematodes, namely, *Trichuris*, *Ancylostoma*, and *Necator*, is very high, the degree of infestation is extremely light. Out of 250 examinations, about 60 per cent were found to be positive for whipworm and hookworm. With very few exceptions, infestations with these nematodes, as judged by the scarcity of ova in concentrated sediments of fecal samples, were very light. The frequency of infestation with *Ascaris* has been found to be lower than that of whipworm and hookworm, but numerous

eggs have been found in positive fecal samples. These observations are in harmony with autopsy findings which show almost invariably light infestations with whipworm and hookworm and from moderate to heavy infestations with ascarids. Inasmuch as living conditions in the Philippines favor heavy helminthic infections, it may be concluded that Filipinos are comparatively immune to infestations with *Trichuris*, *Ancylostoma*, and *Necator* and that they are quite susceptible to infestations with *Ascaris*. Possibly an initial light infection with whipworm and hookworm establishes an immunity to further parasitization. The possible presence of such immunity in Filipinos is being investigated by serological methods.

7. *Intestinal protozoan infections as an index of personal hygiene and institutional sanitation.* WILLIAM C. BOECK, University of Wyoming.

Protozoan surveys conducted in England and a similar survey in this country completed by the U. S. Public Health Service on June 30, 1921, have shown that the incidence of protozoan infections was higher among persons confined in institutions than among those leading a free existence. Confinement was in some way responsible. As a part of the latter survey, 190 patients were examined from an asylum, 108 prisoners from a northern penitentiary, 77 training school boys, and 38 industrial school boys and girls. These persons had been admitted to their respective institutions since 1915. Another series comprises 545 patients who had been confined in the asylum from 1 to 42 years. The results of these examinations were: 1) The incidence of infection was found to increase with additional years of confinement. 2) a large number of pure (single) and a smaller number of mixed (double, triple, etc.) infections occurred among persons but recently admitted to an institution, while the opposite was true among persons who had been confined for longer periods. The number of pure infections became mixed later on by the acquisition of new infections. 3) The spread of protozoan infections seemed the result of low standards of personal hygiene and institutional sanitation. Less infections were found among the prisoners than among the other institutional cases, which was attributed to the excellent standards of personal cleanliness and institutional sanitation in the prison which did not obtain to same degree in the other institutions.

8. *Ophiotaenia testudo* nov. spec. from *Amyda (trionyx) spinifera*. THOMAS BYRD MAGATH, Mayo Clinic.

The description of a cestode found in the intestine of the soft-shell turtle (*A. spinifera*) from Lake Pepin, Lake City, Minnesota, is presented. This record is believed to be unique in the respect that no descriptions have been made in American literature of cestodes from turtles although many animals have been examined from the Mississippi River. Twenty turtles were examined, all or thirteen, whose carapaces were over 8 inches long harbored the parasite, those under 8 inches were not infected. The chief food of this turtle at Lake City is crayfish, which being the distinctive food of the soft-shell turtle suggested the crayfish as the intermediate host. Many were examined without success, as were attempts to experimentally infect them. The worm belongs to the genus *Ophiotaenia*, but is unlike any of the described species. Length 50 cm., maximum breadth 1.6 mm. Scolex, 0.63 mm. wide and 0.42 mm. long. A median fifth

sucker is absent. The four suckers are 0.12 mm. \times 0.10 mm. Genital pore irregularly alternating at the end of the anterior sixth. Cirrus pouch, 0.56 mm. \times 0.27 mm.; ductus ejaculatorius is coiled and the testes (about 200) are in two lateral fields. The vaginal opening is anterior to that of the cirrus. Ovaries, alated; vitellaria extend nearly to the anterior margin of the proglottid. The arrangement of the female genital organs is essentially like that of the other members of the genus. The uterus is median and has about fifteen pouches. The gross diameter of the eggs is 0.030 mm. This paper will be published as a contribution from the United States Bureau of Fisheries Biological Station at Fairport, Iowa, and the Section on Clinical Pathology, Mayo Clinic, Rochester, Minnesota.

9. *Otacariasis in the fox.* WM. A. RILEY, University of Minnesota.

Ear canker is a widely distributed and serious difficulty among domesticated foxes. Unlike that of rabbits, it is not due to *Psoroptes*, but to a species of *Otodectes*. Experimental and control work will be reported.

10. *A new venture in the field of practical parasitology.* (Motion pictures.)

B. H. RANSOM, U. S. Bureau of Animal Industry.

Recent discoveries concerning the life-history of *Ascaris lumbricoides*, a common and highly injurious roundworm parasitic in human beings and in swine, have suggested the possibility of minimizing the losses caused by this parasite among young pigs. At present in many localities these losses are very serious, to the great detriment of the live-stock industry. During the last two years some attempts at a practical control of roundworm infection have been made by the Bureau of Animal Industry of the U. S. Department of Agriculture on a considerable number of farms in the Middle West with highly successful results.

11. *The host-parasite method of investigation and some problems to which it gives approach.* M. M. METCALF.

Problems as to 1) Taxonomic relations between hosts; illustrated from Vernon Kellogg's work upon bird-lice. 2) Taxonomic relations between parasites; illustrated from Aphides. 3) Place, and time of origin and migration routes of hosts; illustrated from the genera *Hyla* and *Bufo* and their *Opalinidae*. 4) Place and time of origin of the parasites and their migration routes; illustrated from *Zelleriella* and *Protoepalina*. 5) Paleoclimatic conditions; illustrated from evidence from the present geographical distribution of *Anura* and *Opalinidae*, a) as to drought in northern Mexico, b) as to temperature and moisture in Antarctica. 6) Conditions of forestation and moisture in the past; illustrated from Central America and South America and a study of their *Hylids* with their *Opalinids*. 7) Ancient land connections; illustrated from the Americas and evidence from fishes Amphibia and their parasites; also from Johnson's work on Australian Cestoda and Trematoda. Comprehensive, concomitant studies of host and parasite among both animals and plants is of essential importance in reconstructing paleogeography in all its phases, and is of great value from other points of view.

12. *The rôle of domestic chickens and pigs in the spread of hookworm disease.* JAMES E. ACKERT, Kansas State Agricultural College.

Feeding experiments with domestic chickens and pigs, conducted last summer in Trinidad, British West Indies, demonstrated that these animals act as vectors in the spread of hookworm disease. By administering hookworm eggs in human excrement to chickens, it was shown that not only do such eggs remain viable in passing through the fowls, but they produce infective hookworm larvae in a medium of chicken feces and animal charcoal or soil. However, a series of quantitative tests indicated that a majority of the hookworm eggs swallowed by chickens fail to produce infective larvae. This failure was attributed to breaking of eggs in the gizzard, injury from urine in the feces, and to malnutrition of the larvae in the excrement. On the other hand, the experiments show that chickens may bring hookworm eggs from remote places up to the drinking dishes, and thus establish infective spots frequently traversed by the barefooted civilians. Newly hatched hookworm larvae pass through the digestive tract of chickens apparently uninjured, but infective larvae administered to chickens do not pass at once from the fowls. On the whole, the domestic chicken appears to be more beneficial than harmful in the control of hookworm disease in Trinidad. Unfortunately, not so much can be said for the pig whose masticatory, digestive and excretory systems so closely resemble those of man. Results of experimental feedings indicated that the majority of hookworm eggs swallowed by pigs produced infective larvae in a culture medium of pig feces and soil.

13. *A study of the resistance of different hosts to Trypanosome infections.* W. H. and L. G. TALIAFERRO, Johns Hopkins University.

The resistance which an animal offers toward a trypanosome infection may be directed either toward a retardation of the rate of reproduction of the parasites or toward their actual destruction after they are formed. We have been able to distinguish between these two conditions, first, by counting the trypanosomes per unit volume of blood and, second, by ascertaining their comparative rate of reproduction as is shown by their coefficient of variation for size. The use of the coefficient of variation as a measure of the rate of reproduction is making use of the obvious fact that a rapidly reproducing population of protozoa is more variable than one in which there is little or no reproduction. Its great value lies in the fact that its determination is independent of the actual number of organisms present. Studying the problem of resistance along these lines, we have reached the following conclusions: 1) in *T. lewisi* in the rat, a resistance develops which both retards the rate of reproduction of the parasites and destroys them after they are formed; 2) in *T. brucei*, etc., in guinea-pigs and dogs, the resulting resistance leads to the destruction of the parasites after formation with no appreciable effect on the rate of reproduction, and, 3) in *T. brucei*, etc., in rats, no resistance on the part of the host develops either toward their rate of reproduction or their destruction after formation.

14. *The anomalies in the group of blood-infesting trematodes.* HORACE W. STUNKARD, New York University.

The group of blood-inhabiting trematodes at the present time comprises three families, the Schistosomatidae, the Spirorchidae, and the Aporocotylidae. The

first of these families is the best known and contains the bisexual forms parasitic in the blood vessels of birds, cattle and man. The Spirochidae are hermaphroditic forms parasitic in the vessels of turtles, and the Aporocotylidae are also hermaphroditic occurring in the blood vessels of fishes. Probably no other trematode group presents such unusual variety and diversity, and no adequate explanation has as yet been presented for this condition. Common characteristics are found throughout the group, but within the families and even genera great morphological disparities are present. The fish parasites are without organs of adhesion, one genus of turtle parasites has only an oral sucker while the other has both acetabulum and oral sucker, and in the family Schistosomatidae there are genera without suckers and others with both ventral and oral adhesive organs. In the Aporocotylidae the genital pore is dorsal, in the Spirochidae it is ventral and somewhat lateral, and in the Schistosomatidae it is ventral, either in the median line or to the right or left of it. Within each family there are representatives with a long coiled uterus containing many eggs, and others with a short uterine portion of the female genital duct containing a single egg. These major differences are accompanied by minor differences and constitute a large and unusual list of anomalies in the group of blood infesting trematodes.

15. *Some additional results obtained in the study of infectious anemia of horses.*

JOHN W. SCOTT, University of Wyoming.

Principal results since previous reports include: 1) *Tabanus septentrionalis* can transmit the disease. 2) Saline tabanid extract produces anaphylactic reaction only. 3) Some horses have a high degree of natural immunity, show no apparent symptoms, and still are carriers of highly virulent blood. 4) The course and character of the fever usually serves to distinguish horses infested with parasitic worms from chronic cases of swamp fever. 5) Blood of one carrier has been virulent over five years. 6) Experiments have proved that the virus is present in the nasal secretion, thus suggesting new possibilities in transmission. 7) In the course of the disease, the erythrocytes gradually diminish but frequently regain the normal number, the hemaglobin content remains closely proportional to the number of erythrocytes present, and the leucocytes increase at a fever period. 8) With cooperation of Dr. S. H. Burnett, it was found that the total increase of leucocytes was due, chiefly at least, to increase in polymorphonuclears and that the eosinophiles disappear or greatly decrease during a fever reaction. In cooperation with Dr. F. S. Jones, of the Rockefeller Institute, contrary to findings of the Japanese, we were unable to find spirochaetes, 1) in stained blood smears or, 2), by using dark-field illumination, in fresh citrated blood either before or after centrifuging, in fresh smears of spleen, kidney, liver, and lymph gland, or in Noguchi cultures from such organs and from the blood. 3) A very minute rod-like organism was found in some cultures, nature unknown, since inoculations so far have given negative results.

16. *Sporulation and development of the cysts in a new species of Myxosporidia, Lentospora ovalis.* H. S. DAVIS, University of Florida.

Gills of the buffalo-fishes, *Ictiobus bubalus* and *I. cyprinella* from the Mississippi River at Fairport, Iowa, are often badly infected by a new species of Myxosporidia, *Lentospora ovalis*. The parasites are carried to the gills in the

circulating blood as amoeboid plasmodia containing three or four nuclei. These nuclei become differentiated into two distinct types, vegetative and generative, which have very different functions. Both types multiply rapidly, the generative much faster than the vegetative. The cysts normally develop within the blood vessels, the walls of which become greatly distended. Each pansporoblast develops from a single cell, the first evidence of the formation of the definitive pansporoblast being a heteropolar division which divides the cell into two very unequal parts. The daughter cells remain closely associated after division and from them are derived all the cells of the pansporoblast. The smaller cell divides but once to form the two envelope cells which become flattened and form a thin covering for the remaining cells of the pansporoblast. Each pansporoblast forms two spores of six cells each. In late stages of the pansporoblast small deeply staining chromatoid bodies are often present. Their origin was not determined but it is not believed they are reduction nuclei since their number and size is very inconstant. No evidence was obtained of any sexual process during the development of the spores. The spores continue to develop until the cysts reach a diameter of about 500 to 700 μ .

17. *On the migration of the sheep lung worm, Dictyocaulus filaria.* JOHN E. GUBERLET, Oklahoma Agricultural Experiment Station.

The writer ('19), in the case of *Dictyocaulus filaria*, has shown that infestation takes place through the mouth and that the larvae migrate to the lungs. It was thought for a time that the migration of lung-worm larvae took place as in *Ascaris*, as has recently been shown by Stewart ('17, '19), Ransom and Cram ('21), and Yoshida ('19). Recent experiments with *dictyocaulus* in which gross infection was produced by giving numerous larvae almost daily over a period of twenty days have thrown some light on the matter. At the end of twenty days the lamb was killed and autopsied. Numerous larval worms were present in the blood. Mesenteric lymph glands, liver, spleen, and kidneys, as well as lungs, contained larval worms. The mesenteric lymph glands were much enlarged. Previously, it was observed that lung symptoms first appeared about twenty days after inoculation. In this case no symptoms appeared until the eighteenth day. Blood was occasionally drawn from the jugular vein, the last being taken on the fourteenth day, with negative results. Apparently, the larval worms do not enter the blood stream at once, but remain in other organs, very probably in the mesenteric lymph glands for some time before entering the blood which carries them to the lungs. The presence of larvae in the liver, spleen, and kidneys is undoubtedly a late development and due to the circulation. Subcutaneous inoculation with larval worms gave negative results.

18. *Studies on Spirochaeta duttoni in the tissues of its invertebrate host, Ornithodoros moubata.* E. MELVILLE DU PORTE, Macdonald College, McGill University.

The spirochaete was found to be still present in three races of laboratory-reared ticks brought to this country originally in 1913. Sections of the ticks show the presence of the spirochaete in most of the organs and tissues including the cephalic glands, brain, mesenteron, uterus, ova, and the connective, adipose, and muscular tissues. The eggs may become infected within the ovary or in their passage through the uterus. Eggs that escape infection within the body of

the tick may be infected after being laid since the secretion of the cephalic gland, with which they are covered, may contain large numbers of spirochaetes.

19. *A little-worked source for parasite material.* M. M. METCALF.

Museum specimens of animals preserved in alcohol give workable material of many internal parasites, especially nematodes and ciliate infusoria. Formalin material is unsatisfactory. The generous attitude of the United States National Museum. The importance of using such material in many museums. It is important in collecting, that both the larger organisms and their parasites should be in mind in deciding methods of killing and preservation.

20. *A coelomic coccidian of Tribolium.* WM. A. RILEY and LAURENCE KROGH, University of Minnesota.

While Coccidia are widely distributed and numerous in species, coelomic forms have been rarely noted. Three species have been reported for insects and two for Oligochaetes. An apparently new species has been found abundantly in flour beetles belonging to the genus *Tribolium*. Life-history studies and infection experiments are to be reported.

21. *On Leptotheca ohlmacheri, a myxosporidian parasitic in frogs.* R. KUDO, University of Illinois.

About 40 per cent of *Rana clamitans* and *R. pipiens* studies were found to be infected by a myxosporidian, *Leptotheca ohlmacheri*. The spores had been known since Ohlmacher ('93) found them in the kidney of *Bufo lentiginosus*. The seat of infection is the lumen of the uriniferous tubule and the space between Bowman's capsule and the glomerulus of malpighian body of the kidney. The infection of a new host animal seems to take place per os. The spore germinates in the stomach under the influence of gastric fluid. The amoebae penetrate through the intestinal wall and pass into the coelom, hence into the uriniferous tubule or malpighian body by way of nephrostome or blood vessels. The spore contains two independent uninucleate sporoplasms which fuse into one mass at the time of germination. The nuclei seem to unite later. The young stage found in the tubules of the kidney is small uninucleate form. Schizogony in this stage seems to be of probable occurrence. The uninucleate form grows. The nucleus divides into two, one vegetative and the other generative nucleus. The former by undergoing further divisions produces trinucleate gemma which becomes separated from the mother body. The latter divides into two generative nuclei, each of which develops into a spore. The trophozoites are usually disporous. The vegetative nucleus persists throughout the entire trophic life of the trophozoite. The parasite does not seem to exercise fatal effect upon the host animal.

22. *Notes on two new species of holostomidae.* JOHN E. GUBERLET, Oklahoma Agricultural Experiment Station, Stillwater.

Two species of Holostomidae were found in the intestine of a loon (*Gavia immer*) killed near Stillwater, Oklahoma. These proved to be undescribed species belonging to two genera, *Hemistomum* Diesing ('50) and *Strigea* Abildgaard (1790). For the former the name *Hemistomum gavium* is proposed. This

is a small form 1 to 1.5 mm. in length. The flattened anterior region, 0.30 to 0.40 mm. in breadth and 0.094 mm. in thickness, comprises approximately two-thirds of the body length. The adhesive disk is posterior to the acetabulum, but does not cover it. The posterior cylindrical region is 0.24 to 0.28 mm. in diameter. For the species in the latter genus the name *Strigea aquavis* is proposed. This species is 2.5 to 3.5 mm. in length. The cup-shaped anterior region measures 0.5 to 0.75 mm. in length and 0.6 to 0.9 mm. in diameter. This region contains the oral sucker, acetabulum, and adhesive disk, or hold-fast organ. The oral sucker and acetabulum are approximately of equal size. The hold-fast organ is composed of leaf-like structures which protrude anteriorly. The cylindrical posterior region, 0.45 to 0.55 mm. in diameter, contains the reproductive organs. Heretofore, only one North American species of *Hemistomum* has been recorded, that being *Hemistomum craterum* Barker and Noll ('15), from *Fiber zibethicus*. The only species of the genus *Strigea* previously reported from North America is *Strigea cornu* Rud., from *Ardea herodias* by Stiles and Hasall ('94).

I. COMPARATIVE AND GENERAL PHYSIOLOGY.

1. *Mutual reactions of cell-bodies and pseudopodial fragments of Diffugia.* WM. A. KEPNER and B. D. REYNOLDS, University of Virginia.

1. In *Diffugia* we have non-nucleated ectoplasmic fragments fusing with the parent cell, resulting in restitution. 2. The parent cell and ectoplasmic fragment are guided to each other by some chemical means other than carbon dioxide, or urea. 3. Fusion never occurs at the ends of the parental pseudopod, but is always effected along an extended midregion; therefore, there must be a difference between the ends and the middle of such pseudopods. 4. The response between a severed fragment and the parental cell is mutual, the direction of approach being shifted to correspond to the changing positions of the protoplasms involved. Movement on the part of an enucleated ectoplasmic fragment seems to be more than aimless. 5. All mutual reactions between protoplasmic fragments and cells were found to be individual rather than specific. Our observations indicated that if an individual protoplasm be separated there would be a tendency to restitution of the whole; but even though one cell be deprived of a part of its body, if protoplasm of another species, or from another individual of the same species, be placed in proximity to it, there will be no response. Thus it is emphasized that after all there is something peculiar in the individual's make up. This peculiarity may be due to the allotment of germ-plasm assigned to the individual at cell division, or to the changes wrought by the flux of the life of the individual since separation from its parent, or both.

2. *Reactions to light of the earthworm, Lumbricus terrestris.* WALTER N. HESS, DePauw University.

Earthworms, which are negative to light of ordinary intensities, become positive, in keeping with their nocturnal habits, when the light is greatly diminished. If, however, the brain is removed either by a dorsal incision or by the removal of the first three anterior segments, they no longer react negatively to ordinary illumination, but become strongly positive, and if six or even more of the anterior segments are removed, they are still positive. Similar results were obtained with

Allolobophora foetida with as many as forty anterior segments removed. These results show that the brain of the earthworm is not necessary for reactions to light and photic orientation. They indicate that earthworms are more sensitive to light when the brain and the photoreceptors at the anterior end are functional, than they are when they are not functional. This accounts for the fact that, while normal worms are positive only in very weak light, specimens with the brain removed are positive in strong light.

3. *The rate of metabolism of Paramecium with controlled bacterial food supply.*

GEO. T. HARGITT and RUTH L. PHILLIPS, Syracuse University.

It is easy to sterilize *Paramecium* so that no bacteria remain adhering to its body, and by using ordinary bacteriological technic it is also feasible to control the bacterial content of a culture fluid. The two methods combined enable one to control the food of *Paramecium* experimentally, as rigidly as desired. The rate of metabolism of *Paramecium* has been tested under these conditions of controlled bacterial food. The bacteria used were taken from ordinary hay infusions and used either in pure cultures or as mixtures of 2 or 3 kinds. All experiments were checked by the metabolic rate of *Paramecium* fed on the usual unknown bacterial mixture of the hay infusion. Some of the experiments covered only a few days or weeks, others extended over a period of six months, and two were observed for nine months.

In general the highest rate of metabolism seems to occur in such complex mixtures of bacteria as are found in hay infusions. The single pure culture of bacteria which was successful gave a low rate of metabolism for *Paramecium*, but the rate was fairly uniform. Mixtures of bacteria gave excellent results with a rather high rate of metabolism, though usually not so high as with the more complex mixtures of the hay infusion. Tests were also conducted upon the effect of changing the bacterial food from time to time. It was concluded that if the food was satisfactory at first a continuance of this food gave higher and more constant rates of metabolism than a change of food.

4. *The feeding reactions of Amblystoma tigrinum (Green).* ALBERT KUNTZ and JOSÉ ZOZAYA, St. Louis University School of Medicine.

This paper comprises the results of experimental work carried out at the Macbride Lakeside Laboratory during the summer of 1920 which may be summarized as follows: The typical response of the larvae of *Amblystoma tigrinum* to the presence of food consists of an 'approaching' and a 'seizing' reaction. Young adults frequently exhibit also a 'nosing' reaction. The 'approaching' reaction is commonly a visual response. The 'nosing' and 'seizing' reactions, except when the latter follows the 'approaching' reaction more or less spontaneously, involve the olfactory sense. Moving objects are detected and pursued more promptly than objects which are not in motion. In the absence of sight food is detected by the sense of smell. Discrimination between edible and inedible objects also involves the olfactory sense.

5. *The rôle of the nervous system in the locomotion and regeneration of marine polyclads.* J. M. D. OLMSTED, University of Toronto.

The locomotion of polyclads is comparable with that of gastropods. Ataxic locomotion is a local phenomenon, but controlled by the nervous system since

it is abolished by chloretone. Certain species progress only by this method. Ditaxic retrograde locomotion is under the control of the cephalic ganglia, each ganglion governing the progression of muscular waves on its own side. The nerve cords serve as conductors for impulses leading to wave formation each on its own side. Cutting one nerve causes the waves to disappear on that side at the level of the cut. Ciliary action is not under the control of the nervous system and plays practically no part in locomotion. For the swimming movement it is necessary that the cephalic ganglia be intact. Injury to or loss of the brain prevents the animal from employing this method of locomotion. Polyclads are able to restore missing parts provided the cephalic ganglia are intact. If these are injured nervous tissue is not added to restore the brain to its original size, and if they are entirely removed regeneration can not take place anteriorly, though it may do so posteriorly. If a portion of the brain remains, a certain amount of anterior regeneration takes place and eyes are regenerated, but not enough material is added to restore the original form, and the new eyes never reach the size of the old ones.

6. *A quantitative study of tarsal sensitivity to solutions of saccharose in the Red Admiral butterfly, Pyrameis Atalanta (linn).* DWIGHT E. MINNICH, University of Minnesota.

The author has previously shown that the tarsi of the red admiral butterfly, *Pyrameis atalanta* (Linn), are sensitive to contact chemical stimulation. One substance sharply distinguished through the tarsi is a 1M solution of saccharose. If the tarsi are brought in contact with this solution *Pyrameis* always responds by extending the proboscis, irrespective of its nutritional condition. The animal may also respond if the tarsi are brought in contact with distilled water, but only after a more or less prolonged period of total inanition. Moreover, the administration of water immediately inhibits the response. It is possible, therefore, to maintain *Pyrameis* in a state of 100 per cent responsiveness to 1M saccharose, but of 0 per cent responsiveness to water alone. Under these conditions the minimal concentration of saccharose necessary to effect a response, i.e., the threshold concentration, is readily determined. Seven butterflies were intensively studied under varying nutritional conditions. The results show that the threshold of response to saccharose varies directly with the nutritional condition. During periods of inanition with respect to saccharose the threshold gradually falls, and may reach such levels as M/3200, M/6400, or even M/12,800. But with the initiation of a period of saccharose diet, the threshold rises abruptly to a level usually of about M/10, where it remains approximately constant as long as the diet continues. Compared with other animals, the sensitivity to saccharose in *Pyrameis* is very highly developed. This is doubtless correlated with the fact that sugars form the chief food of this insect.

7. *A micro-Winkler method for quantitative determination of dissolved oxygen.* E. J. LUND, University of Minnesota.

It has been found possible and entirely practicable to determine dissolved oxygen in quantities of water of 10 cc. or even less by employing 0.1 cc. each of the solutions KI-NAOH, and $MnCl_2$ ordinarily used in the Winkler method, instead of 1 cc. of each of these solutions. The thiosulphate solution of the

usual concentration is diluted ten times or even more if necessary. Addition of the reagents is best accomplished from micro-burettes, drawn to long capillary points. Titration in a small, deep dish is carried out with a burette reading to 1/20 cc. Loss of iodine is proportionately not greater than in the usual method. The limit of error is about 0.005 cc. or 0.007 of a milligram of oxygen gas. This procedure represents, therefore, by far the most delicate method ever devised for the quantitative determination of oxygen. Special procedures are used to remove protozoa, small pieces of tissue, etc., from the water before analysis. A full account of the methods will appear in the publications of the Puget Sound Marine Biological Station.

8. *A contribution to the colloid chemistry of protoplasm.* L. V. HEILBRUNN, University of Michigan.

Recent work on colloid chemistry has shown that the electric charge on the particles of colloidal solutions is of especial importance. Primarily it is this charge that keeps the colloidal particles dispersed through the liquid that contains them. Some colloidal solutions are positively charged, others negatively. It is essential to determine whether protoplasm is a positive or negative colloid. This can be done by an indirect method. Sea-urchin eggs were placed in isotonic solutions of various salts and then after varying intervals of time the protoplasmic viscosity was compared. Calcium chloride tends to liquefy the protoplasm, magnesium chloride also acts in this way, although less strongly; on the other hand, potassium, sodium, and ammonium chloride tend to precipitate protoplasm and their effect increases in the order named. The results indicate that protoplasm is positively charged. But the surface layer is negatively charged, for the very salts which coagulate the protoplasm cause the plasma membrane to swell, and those that liquefy the protoplasm tend to prevent this swelling. The results not only furnish evidence as to the charge on the colloidal particles of protoplasm, but they also provide an easy and rational explanation of the phenomena of antagonism.

9. *Transplantation of the pars nervosa of the pituitary.* W. W. SWINGLE, Yale University.

Subcutaneous homoplastic and heteroplastic transplantation of the pars nervosa of adult *R. clamata* and *R. catesbeiana* into larvae cause shrinkage and emaciation after twelve hours. Control grafts of the pars anterior and brain tissue show no such effect. The larvae vary in their reaction to the graft, but in none does the shrinkage persist following resorption of the implanted tissue. The experiments indicate that the shrinkage and emaciation of the tadpoles are due to the well-known diuretic action of pars nervosa secretion, and not to muscular contraction. In frog larvae the activity of the mesonephros is intimately associated with maintenance of normal body appearance. Tadpoles constantly absorb water through the skin, circulate it through the lymph and blood system finally eliminating it by means of the mesonephros. A continual stream of water passes through the organism; the tissues, body cavity and lymph sinuses are turgid, and it is owing to this fact that under normal conditions the tadpole body has a round oedematous appearance. Processes of absorption and elimination are in equilibrium, but any block in the kidney function or undue

stimulation of renal activity overthrows the equilibrium and the appearance of the larva changes. Blocking the kidney function leads to rapid and fatal oedema; transplanting the pars nervosa, the secretion of which apparently acts upon the larval mesonephros as it does on the mammalian metanephros by stimulating the secretory cells to greater activity, leads to shrinkage and emaciation owing to loss of turgor through increased elimination of water.

10. *Photic orientation in the robber-fly, Proctacanthus.* S. O. MAST, The Johns Hopkins University.

Specimens with middle and front legs on one side removed orient fairly accurately.

If the upper surface of one eye and the lower surface of the other are covered the insects, if properly illuminated, lean toward the former and turn toward the latter. If one eye is covered and the illumination is confined to a small portion of the other, the legs on both sides respond in such a way as to tend to cause the animal to turn toward the illuminated surface, no matter where it is located. If the illumination is confined to a certain portion of the anterior surface the insect goes fairly directly toward the light, although only one eye receives light. In light from two sources of unequal intensity the two eyes are also unequally illuminated when the insects are oriented.

The turning effect of the illumination of a given region of the retina on one side is neutralized by equal illumination of the same region of the retina on the opposite side or by lower illumination of regions relatively farther back.

These facts and others prove conclusively that the tonus hypothesis, or any other that demands balanced action in receptors and locomotor appendages on opposite sides, does not fully account for orientation in *Proctacanthus*. They show that it is dependent upon series of coordinated reflexes in the legs on both sides specifically related to the localization of the stimulus in either eye and inhibition of the effect of illumination in one eye by simultaneous illumination in the other.

11. *Light and growth in animals.* A. G. HUNTSMAN and F. FRASER, University of Toronto.

The growth of the mussel (*Mytilus edulis*) was found to be greatly impeded by exposure to full sunlight. This effect was shown to a greater degree in the antero-posterior and the dorsoventral than in the transverse axis or than in the weight of dry material. A comparison has been made of growth in full direct sunlight with that in direct sunlight diminished to about one-eighth. The rock barnacle (*Balanus balanoides*) shows nearly twice as much increase with the lower illumination. Colonies of *Clava leptostyla* show more than twice as great an increase in the number of zooids with the lower illumination.

12. *'Reversal of inhibition' in insects by atropine.* W. J. CROZIER, Rutgers College.

Representatives of a number of invertebrate phyla have been found to show under influence of strychnine a special excitation of extensor neuromuscular elements, such that there appear phenomena of opisthotonus and of reversal of inhibition. With insects strychnine is singularly ineffective in these respects,

and is of very slight toxicity. Sphingid and other large caterpillars, however, do show pronounced neuromuscular 'reversals' in connection with the antagonistic muscles controlling movements of the prolegs, but only when atropine has been injected; none of a series of neuropile substances, save atropine, acts in this manner. Annelids do suffer differential neuronic excitation under strychnine, as can be demonstrated very completely in leeches. With crayfish, strychnine is very slightly toxic, but does stimulate certain neuromuscular groups (leading to forward progression), and may produce opisthotonus. These facts point to chemical peculiarities of the insect nervous system, differentiating it from that of groups phylogenetically akin; and consequently have a direct bearing upon the conception of progressive chemical specialization of the nervous system.

13. *Electrical polarity in Obelia.* E. J. LUND, University of Minnesota.

A definite difference of electrical potential occurs in the stem of the colony of *Obelia*, such that the apical growing region is electronegative to the middle or more basal region. This electrical polarity is associated with the living tissue of the coenosarc and does not originate in any other structure of the stem for on potential difference occurs in: a) stems left to die and macerate in sea water; b) stems from which the living tissue has been removed mechanically, and, c) stems in which the living tissue has been killed by chloroform. The magnitude of the fall of potential varies in pieces of stems from different colonies. It also varies along the length of the stem of the same colony, being greatest in the apical actively growing region. The general conclusion from the experiments is that, since normally inherent differences of electrical potential occur in the stem of *Obelia* and are associated with apical growth, then it should be possible to inhibit or modify developmental processes by appropriate application of an E. M. F. of external origin. This was shown to be possible in the previous paper reported to this society a year ago.

14. *Circus movements in negatively heliotropic Limax.* W. J. CROZIER and W. H. CQLE, Rutgers College and Lake Forest College.

Analyses are already available of circus-movements executed by positively heliotropic organisms under suitable conditions, and the significance of these movements for the theory of heliotropism is generally recognized. We are able to show that in the negatively heliotropic slug *Limax*, with non-directive illumination, the animal circles continuously toward that side on which tip of the eye-tentacle (including the eye) has been removed. The diameter of the circular path varies inversely with the light intensity. It is found that the eyes, or structures in their immediate vicinity, are the effective receptors; upon regeneration of the eye following unilateral amputation, there is progressive return of typical orientation.

15. *The effect of chemicals on locomotion in Ameba. I. Reactions to localized stimulation.* J. GRAHAM EDWARDS (introduced by S. O. Mast), The Johns Hopkins University.

Localized stimulation was obtained by allowing various chemicals to diffuse from a capillary pipette against the surface of the ameba. The response depends

upon the composition of the medium in which the ameba is when stimulated. The following results were obtained from observations of specimens in N/500 KCl. In this solution they travel uniformly and monopodally. Acids (N/5 to N/500) cause a violent positive response. A protuberance is formed at the point stimulated which persists until incorporated in the folds at the posterior end; in lower concentrations, a small pseudopod is initiated which, however, does not persist. The response is in all cases more immediate and larger the nearer the anterior end the stimulus is applied, being negligible at the posterior end. The effect apparently depends on a local swelling of the ectoplasm with subsequent gelation. Hydroxides (N/5 to N/500) cause a broad sheet of protoplasm to flow toward the pipette, after which streaming continues in another direction. In lower concentrations, a small pseudopod is formed but does not persist. The effect here, as in acids, seems dependent on swelling of the ectoplasm, but without subsequent gelation. Salts induce various responses depending on their concentration and composition. Local changes in permeability seem to condition these responses. Alkaloids and non-electrolytes induce negative responses. If the leucobase of methylene blue is applied anteriorly, the endoplasmic flow stops and the ectoplasm wrinkles at the point of application. If applied laterally, an indentation is formed at the point of application and the ameba becomes crescent-shaped.

16. *A quantitative study of the reactions to light in Amoeba.* HARRY T. FOLGER (introduced by S. O. Mast), The Johns Hopkins University.

Amoeba reacts to sudden increase in illumination by complete cessation of movement. The time from the beginning of stimulation until this cessation occurs varies with the intensity of the light. It becomes shorter as the intensity increases. The decrease in reaction-time, however, is not proportional to the increase in intensity. The amount of light-energy (meter-candle-seconds) received during the reaction-time is greater in higher than in lower intensities. To secure a response, exposure for only a definite portion of the reaction time is necessary, the reaction taking place at precisely the same time as if the illumination had been continued. Thus the reaction-time may be divided into two parts: a) a stimulation-period during which the animal must be exposed to light to get a response; b) a latent period during which exposure is not necessary. The latent period varies greatly in different animals, under the same environmental conditions. Usually it is practically constant in any individual for a moderate length of time. However, there are occasional fluctuations which sometimes take place gradually but which may occur suddenly. Such changes in the latent period amount in some cases to more than 100 per cent and are apparently independent of any change in the environment. The stimulation-period varies inversely with the intensity of illumination. The light energy received during this period is constant. Dark adaptation is necessary for a response. This process usually requires less than one minute.

17. *The influence of temperature on the rate of locomotion in Amoeba.* ALPHONSE M. SCHWITALLA (introduced by S. O. Mast), St. Louis University.

The relation between temperature and the rate of locomotion in *Amoeba* was studied quantitatively by means of a modified Pfeiffer stage and thermocouples.

At constant temperatures there are alternate periods of acceleration and retardation in the rate of locomotion. These periods are readily interpretable as phases in a locomotor rate-rhythm. They are coincident with eruptive and quiescent periods of activity as manifested by the rate of flow in the endoplasm. The relation between the two phases is constant under certain conditions but not under others. The average rate of locomotion increases with a rise in temperature until a maximum is reached at about 25°, after which it decreases. The value of the van't Hoff temperature coefficient (Q_{10}) for a given individual under different conditions is extremely variable, but not more so than it is for certain other physiological processes. The evidence points to the conclusions that there is no direct quantitative relationship between temperature and the rate of locomotion, and that temperature affects the rate of locomotion only through its effect on the rhythmical processes which condition locomotion.

J. UNCLASSIFIED

1. *The National Research Council Information Service.* ROBERT M. YERKES.

Under this title is offered a brief account of the informational clearing-house for science and technology which is being developed by the National Research Council. The 'Service' is maintained with the cooperation of investigators and for their use. Ordinarily they may consult it without charge. The organization will serve also to disseminate intelligible and reliable information concerning scientific research and the applications of its results. All who are interested in research or its products are invited to make use of the Research Information Service.

ADDITIONAL ABSTRACTS

The following abstracts were received too late to be included in the Abstracts printed before the meeting. The Society voted to receive these and ordered them printed as a part of the proceedings of the meeting. Six of the papers were presented in full at the meetings.

A'. 25. *A lethal gene which changes the order of the loci in the chromosome map.*

H. J. MULLER, University of Texas. Abstract too long to be printed.

C. 9. *The spermatogenesis of man.* THEOPHILUS S. PAINTER, University of Texas.

A study has been made on the spermatogenesis of man using testicular material (from two negroes and a white man) which was perfectly fresh when preserved. The main results are as follows:—there are 48 chromosomes in dividing spermatogonia in both the white and the negro testes. Two of these 48 chromosomes have no synaptic mates of the same size or shape. These are the X and Y sex chromosomes. Primary spermatocytes show 24 chromosomes. The X-Y sex chromosome consists of an element, the two halves of which are very unequal in size. When division occurs, the X chromosome goes to one pole, and the Y to the other.

C. 10. *The spermatogenesis of the opossum.* THEOPHILUS S. PAINTER, University of Texas.

The complete spermatogenesis of the opossum has been worked out, the points of main interest being, (a) the diploid or somatic chromosome number is 22. (Previous investigators have reported 17 and 24.) Two of these have no synaptic

mates of the same size and shape. They are the X and Y sex chromosomes. The X and Y components segregate to opposite poles during the first maturation division, hence half the sperm carry an X and half a Y sex-chromosome. A study of embryos confirmed the above conclusions.

- E. 10. *Notes on the Crocodilia of British Guiana.* ALBERT M. REESE, University of West Virginia.

Of the four species of Caiman described from British Guiana probably only one, *C. niger*, is dangerous to man, though native hunters consider all of the so-called "alligators" dangerous.

Since their hides are not suitable for leather the caimans are not subject to the chief source of danger that has thinned the ranks of the Florida alligator, but they are fairly scarce in some parts of the colony, while very abundant in other parts.

They are extensively killed, on some sugar estates, though it is doubtful if they are not more beneficial as destroyers of rodents than harmful in other ways.

Their nests resemble in form and location those of the Florida alligator, but are often built of finer and entirely "dead" vegetable material.

The eggs are usually smaller (those of *C. niger* were not found) and have usually, though not always, rougher, harsher shells than the eggs of the Florida alligator. The average number of eggs per nest is about 27. About 6 per cent of the eggs examined were infertile. The eggs are mostly laid in the late spring, and hatch in two or three months, the period of incubation probably varying with conditions of temperature, moisture, etc.

- E. 11. *A noteworthy adaptive modification of the webs of a siamese argioid spider.* HENRY E. CRAMPTON, Barnard College.

Along the railroad through the jungles of southern Siam, the telegraph wires provide spaces of varying width in which Argioid spiders construct their webs. The animals probably belong to the genus *Nephila*. Full-sized webs are built where the intervals are suitable. When the interspaces are less than the diameter of a normal web, the spiders modify the structures by omitting an upper sector of greater or less extent, according to an invariable mode of adjustment.

- E. 12. *On the distribution and ecology of the species of Partula inhabiting the Mariana Islands of the Western Pacific Ocean.* (Illustrated with lantern-slides and specimens.) HENRY C. CRAMPTON, Barnard College.

In the course of a recent journey, the species of *Partula* inhabiting Guam and Saipan were investigated, as in earlier studies in Polynesia proper. The general principles of distribution were confirmed, as regards inter-island and, intra-insular differentiation. The environmental influences, as such, are not determinative with reference to the distinctive characters of distinguishable species and subordinate varieties.

- H. 23. *Phases in the life-history of a holostome, Cyathocotyle Orientalis, nov. spec., with notes on the excretory system of the larva.* ERNEST CARROLL FAUST, Parasitology Laboratory, Department of Pathology, Peking Union Medical College, Peking, China.

1. A larval holostome, *Tetracotyle orientalis*, nov. spec. is described from Peking, China.

2. The excretory system of the tetracotyle consists of two parts, a close network of canals with granular inclusions (the reserve bladder), and the system of tubules, capillaries and flame-cells.

3. The analysis of the excretory system of the tetracotyle shows a development along an exact plan, with five main tubules on each side of the body, each tubule draining a system of 32 dorsal and 32 ventral capillaries and flame-cells. Each of these sub-systems is based on a 5-fold dichotomy. The formula $\alpha + \beta + \gamma + il + \epsilon$ exactly fits such a system. In the adult worm there will probably be an exact multiple of this least common denominator.

4. Of six young ducks carefully examined for infection beforehand, one was used for experimental feeding with the tetracotyliform larvae. Twelve days after the feeding the experimental animal died and at autopsy 75 holostomes were recovered from the ceca. The controls were all negative. The worms are believed to be responsible for a diarrhoeic and possibly dysenteric involvement of the ceca.

5. Some of the worms recovered from the experimental host were adults while others were immature. Study of the adults showed the worms to belong to the genus *Cyathocotyle*. The species is new and is designated as *Cyathocotyle orientalis*.

6. Comparison of tetracotyle, immature and adult worms indicates the progressive changes involved in its growth and gives an insight into certain relationships of the genus and of the group.

I. 19. *The instincts and adaptations of several species of Tortugas fishes.* W. H. LONGLEY, Goucher College, Baltimore.

The local distribution of many species of fishes is determined by the character of the bottom. This is particularly true of what may be called the "sand-patch association," members of which require a substratum of a peculiar character in which they may hide temporarily or construct convenient shelters. *Opisthog-nathus* and *Gnathypops* inhabit vertical burrows, sometimes a foot and a half deep and lined with bits of coral and shell as well as lined with brick. *Toglossus* has unlined burrows more irregular in shape. *Xyrichtys* simply buries itself in the sand when alarmed although there is reason to believe that after its excursions in the open it may return again and again to one place.

Thalassoma nitidus is commonly seen pecking at the surface of larger fishes presumably cleaning ectoparasites from them. These larger fishes return again and again to submit to the process of grooming and will drive away others which interrupt the process.

This *Thalassoma*, whose attentions are not merely tolerated but actually welcomed, is resembled in a striking way by a small blenny, which although rare occurs with it and is notably different from the other blennies in respect to certain reactions which accentuate its superficial resemblance to *Thalassoma*. The relation between the two species appears comparable to a certain extent with the so-called 'Batesian mimicry.'

Slides were used to show peculiarities of form and behaviour of members of the "sand-patch association" and *Thalassoma* in action. Others illustrated the obliterative effect of the changeable coloration of common species of reef-fishes.

- I. 18. *The reflex produced by chemical stimulation of the deeper respiratory passage.* E. HORNE CRAIGIE, Department of Biology, University of Toronto.

The respiratory and circulatory reflexes aroused by the projection of an irritant vapour into the trachea, bronchi, and lungs have been stated by certain observers to be obliterated by double vagotomy, and by others to be unaffected by this operation.

The respiratory response obtained in dogs is found to consist of increased expiratory effort and an inhibition of inspiration.

The vaso-motor response consists of a rather gradual fall in blood-pressure, followed at once by a somewhat slower return to normal. In some cases the fall was preceded by a slight, brief rise in pressure.

Both the respiratory and the circulatory reflexes are entirely unaffected by section of both vagi, which therefore cannot contain the afferent fibers concerned.

- I. 20. *Hen feathering induced in male fowls by feeding thyroid.* BENJAMIN HORN-ING and HARRY BEAL TORREY, University of Oregon Medical School.

When fed thyroid daily, in doses increasing with their weight, from the age of three weeks, our male Rhode Island Red chicks developed plumage of the female type, although males of this breed ordinarily do not pass through a juvenile stage characterized by plumage of the female type. The plumage of capons, usually ultra male, is not affected by thyroid feeding. Castrated females which typically develop male plumage are similarly unaffected. The primary effect of the thyroid feeding seems to be to increase the activity of the 'luteal' interstitial tissue of the testis. The end result is a hen feathered male resembling in all essential characteristics of the plumage the hen feathered males of the sea-bright bantam and campine breeds.

AMERICAN SOCIETY OF ZOÖLOGISTS

CONSTITUTION, OFFICERS AND LIST OF MEMBERS OF THE SOCIETY

CONSTITUTION

ARTICLE I

NAME AND OBJECT

Section 1. The Society shall be called the "American Society of Zoölogists."

Sec. 2. The object of the Society shall be the association of workers in the field of Zoölogy for the presentation and discussion of new or important facts and problems in that science and for the adoption of such measures as shall tend to the advancement of zoölogical investigation in this country.

ARTICLE II

MEMBERSHIP

Section 1. Members of the Society shall be elected from persons who are active workers in the field of Zoölogy and who have contributed to the advancement of that science.

Sec. 2. Election to membership in the Society shall be upon recommendation of the Executive Committee.

Sec. 3. Each member shall pay to the Treasurer an annual assessment as determined by the Society. This assessment shall be considered due at the annual meeting and the name of any member two years in arrears for annual assessments shall be erased from the list of members of the Society, and no such person shall be restored to membership unless his arrearages shall have been paid or he shall have been re-elected.

Sec. 4. Foreign Zoölogists, not members of this Society, may be elected Honorary Fellows upon unanimous recommendation of the Executive Committee by a majority vote of the members present at any meeting of the Society. Honorary Fellows shall not be required to pay dues.

ARTICLE III

OFFICERS

Section 1. The officers of the Society shall be a President, a Vice-President, a Secretary and a Treasurer and the members at large of the Executive Committee.

Sec. 2. The Executive Committee shall consist of the President, the Vice President, the Secretary, the Treasurer and five members elected from the Society at large. Of these five members, one shall be elected each year to serve five years. If any member at large shall be elected to any other office, a member at large shall be elected at once to serve out the remainder of his term.

Sec. 3. These officers shall be elected by ballot at the annual meeting of the Society and their official terms shall commence with the close of the annual

meeting, except that the Secretary and the Treasurer shall be elected triennially and shall serve for three years.

Sec. 4. The officers named in Section 1 shall discharge the duties usually assigned to their respective offices.

Sec. 5. Vacancies in the board of officers, occurring from any cause, may be filled by election by ballot at any meeting of the Society. A vacancy in either the Secretaryship or the Treasurership occurring in the interval of the meetings of the Society may be filled by appointment, until the next annual meeting, by the Executive Committee.

Sec. 6. At the annual meeting the President shall name a nominating committee of three members. This committee shall make its nominations to the Secretary not less than one month before the next annual meeting. It shall be the duty of the Secretary to mail the list of nominations to all members of the Society at least two weeks before the annual meeting. Additional nominations for any office may be made in writing to the Secretary by any five members at any time previous to balloting.

ARTICLE IV

MEETINGS OF THE SOCIETY

Section 1. Unless previously determined by the Society the time and place of the annual meeting of the Society shall be determined by its Executive Committee. Special meetings may be called and arranged for by the Executive Committee. Notices of such meetings shall be mailed to all members of the Society at least two weeks before the date set for the meeting.

Sec. 2. Sections of the Society may be organized in any locality by not less than ten members, for the purpose of holding meetings for the presentation of scientific papers. Such sections shall have the right to elect their own officers and also associate members; provided, however, that associate membership in any section shall not confer membership in the Society.

ARTICLE V

QUORUM

Twenty-five members shall constitute a quorum of the Society and four a quorum of its Executive Committee.

ARTICLE VI

CHANGES IN THE CONSTITUTION

Amendments to this Constitution may be adopted at any meeting of the Society by a two-thirds vote of the members present, upon the following conditions:

(a) The proposed amendment must be in writing and signed by at least five members of the Society.

(b) This signed proposal must be in the hands of the Secretary at least one month before the meeting of the Society at which it is to be considered.

(c) The Secretary shall mail copies of the proposed amendment to the members of the Society at least two weeks before the meeting.

BY-LAWS

DUES

(1) The annual dues for members, unless remitted or changed by the vote of the Society, shall be seven dollars.

SECRETARY

(2) The duties and privileges of the Secretary shall be as follows:

(a) He shall keep the records of the Society.

(b) Whenever the proper officers of a number of related societies shall have a conference with a view to determining a common time and place for the several annual meetings, he shall act as the delegate or representative of this Society. (See also 5.)

(c) He shall employ a typewriter or printer whenever in his judgment such employment will expedite the business of the Society, and

(d) He shall be reimbursed out of the funds of the Society for expenses incurred in attending meetings of the Society.

TREASURER

(3) The duties and privileges of the Treasurer shall be as follows:

(a) He shall be in charge of the funds of the Society.

(b) At the Annual Business Meeting of the Society he shall present a statement to date of the funds of the Society.

(c) He shall employ a typewriter or printer whenever in his judgment such employment will expedite the business of the Society.

AUDITING COMMITTEE

(4) The President shall annually appoint an auditing committee of two, who shall audit and report upon the financial record and statement of the Secretary-Treasurer at the meeting for which they were appointed.

(5) The National Research Council allows the Society three representatives on the Division of Biology and Agriculture. Of these three representatives, one shall be elected each year to serve three years. The method of election shall be the same as that used in the election of the officers of the Society.

MEETINGS

(6) It shall be the policy of the Society to hold meetings in both Eastern and Central-Western territory, and the distribution of the meetings between the two territories shall be determined in general on the basis of the representation of Eastern and Western members in the Society. See also 2-c.

PROGRAM RULES

(7) In matters relating to programs for annual meetings the following rules shall be observed:

(a) Papers shall be listed and presented according to subject matter in the following groups: 1. Comparative Anatomy; 2. Embryology; 3. Cytology; 4.

Genetics; 5. Comparative and General Physiology; 6. Ecology, and 7. Miscellaneous, or other groups at the discretion of the Secretary-Treasurer.

(b) Whenever conditions require it the Executive Committee shall schedule two or more groups for the same hour and rearrange the program to bring together papers on subjects of more general interest for meetings of the whole Society. The Committee, however, is instructed to avoid conflicts as much as possible.

(c) Papers shall be listed in their respective groups in the order received. When a member offers more than one paper those following the one designated first shall be placed at the end of the list and shall not be read until all first papers by members shall have been twice called for.

(d) All papers not read when called for as listed shall be placed at the end of the group list, and, if not read when called for the second time, they shall be read by title only.

(e) The titles of "introduced" papers shall be listed in the groups after the titles of papers to be read by members. Such papers shall be read by title only in case the entire program cannot be completed during four regular sessions for reading papers.

(f) Fifteen minutes shall be the maximum time allowed for the presentation of a paper.

(g) Abstracts of papers for publication in the proceedings of the Society must be handed to the Secretary-Treasurer or his representative before final adjournment of the annual meeting.

HISTORICAL REVIEW

A review of the historical antecedents of the present American Society of Zoölogists will be found in *The Anatomical Record* for January, 1917. The list of officers and meeting places of the present Society found in the same place is brought up to date and reprinted here.

LIST OF FORMER OFFICERS

AMERICAN MORPHOLOGICAL SOCIETY

<i>President</i>	<i>Vice-President</i>	<i>Secretary-Treasurer</i>
1890—E. B. Wilson	J. P. McMurrich
1891—C. O. Whitman	E. L. Mark	J. P. McMurrich
1892—C. O. Whitman	H. F. Osborn	J. P. McMurrich
1893—C. O. Whitman	E. B. Wilson	J. P. McMurrich
1894—C. O. Whitman	W. B. Scott	G. H. Parker
1895—E. B. Wilson	W. B. Scott	G. H. Parker
1896—E. L. Mark	H. F. Osborn	G. H. Parker
1897—C. S. Minot	S. I. Smith	G. H. Parker
1898—H. F. Osborn	T. H. Morgan	G. H. Parker
1899—E. G. Conklin	W. M. Wheeler	Bashford Dean
1900—T. H. Morgan	H. C. Bumpus	J. S. Kingsley
1901—J. S. Kingsley	E. A. Andrews	T. H. Montgomery
1902—H. C. Bumpus	G. H. Parker	M. M. Metcalf

Additional Members of the Executive Committee

1891—E. B. Wilson	1897—J. S. Kingsley
H. F. Osborn	Bashford Dean
1892—E. L. Mark	1898—C. B. Davenport
T. H. Morgan	F. R. Lillie
1893—T. H. Morgan	1899—J. P. McMurrich
C. B. Davenport	G. H. Parker
1894—E. A. Andrews	1900—F. R. Lillie
F. H. Herrick	Jacob Reighard
1895—T. H. Morgan	1901—C. F. W. McClure
S. Watase	C. W. Hargitt
1896—E. G. Conklin	1902—H. S. Jennings
William Patten	R. G. Harrison

AMERICAN SOCIETY OF ZOOLOGISTS

<i>EASTERN BRANCH</i>	<i>President</i>	<i>CENTRAL BRANCH</i>
G. H. Parker	1903	Jacob Reighard
E. A. Andrews	1904	C. H. Eigenmann
W. E. Castle	1905	F. R. Lillie
W. E. Castle	1906	C. C. Nutting
C. B. Davenport	1907	S. A. Forbes
W. M. Wheeler	1908	E. A. Birge
H. S. Jennings	1909	E. A. Birge
T. H. Montgomery	1910	C. E. McClung
H. V. Wilson	1911	George Lefevre
A. G. Mayer	1912	H. B. Ward
Raymond Pearl	1913	H. B. Ward

LIST OF FORMER OFFICERS

EASTERN BRANCH	<i>Vice-President</i>	CENTRAL BRANCH
Jacob Reighard	1903	H. F. Nachtrieb
W. E. Castle	1904	S. J. Holmes
William Patten	1905	William A. Locy
William Patten	1906	George Lefevre
F. H. Herrick	1907	H. B. Ward
H. S. Jennings	1908	M. F. Guyer
H. V. Wilson	1909	M. F. Guyer
H. H. Wilder	1910	H. F. Nachtrieb
H. E. Crampton	1911	R. H. Walcott
G. A. Drew	1912	C. M. Child
Alex. Petrunkevitch	1913	C. M. Child

Secretary-Treasurer

G. A. Drew	1903	Frank Smith
G. A. Drew	1904	F. R. Lillie
H. S. Pratt	1905	C. E. McClung
H. S. Pratt	1906	T. G. Lee
C. J. Herrick	1907	T. G. Lee
L. L. Woodruff	1908	T. G. Lee
L. L. Woodruff	1909	Charles Zeleny
H. W. Rand	1910	H. V. Neal
Raymond Pearl	1911	H. V. Neal
J. H. Gerould	1912	W. C. Curtis
Caswell Grave	1913	W. C. Curtis

Executive Committeemen

F. R. Lillie	George Lefevre
T. H. Montgomery	T. G. Lee
H. C. Bumpus	Herbert Osborn
H. S. Jennings	C. H. Eigenmann
E. A. Andrews	J. G. Needham
W. R. Coe	S. J. Holmes
G. A. Drew	W. A. Locy
M. M. Metcalf	C. M. Child
D. H. Tennent	R. H. Walcott
R. G. Harrison	W. C. Curtis
H. E. Jordan	Oscar Riddle
C. E. McClung	H. B. Ward
	Chauncey Juday
	H. W. Norris
	C. E. McClung
	H. F. Nachtrieb

AMERICAN SOCIETY OF ZOÖLOGISTS (AMALGAMATED)

<i>President</i>	<i>Vice-President</i>	<i>Executive Committeemen</i>
1914. C. E. McClung	M. F. Guyer	H. E. Jordan—1 year H. F. Nachtrieb—2 years H. V. Wilson—3 years George Lefevre—4 ydars A. F. Shull—5 years
1915. W. A. Loey	W. E. Ritter	D. H. Tennant
1916. D. H. Tennent	Charles Zeleny	R. P. Bigelow—5 years L. J. Cole—4 years H. V. Wilson
1917. M. M. Metcalf	Charles Zeleny	M. M. Metcalf
1918. George Lefevre	L. L. Woodruff	George Lefevre
1919. C. M. Child	H. H. Wilder	C. M. Child
1920. Gilman A. Drew	Caswell Grave	G. A. Drew
1921. Charles A. Kofoid	Aaron L. Treadwell	G. A. Kofoid
1922. H. H. Wilder	Bennet M. Allen	

Secretary-Treasurer

1914-1918. Caswell Grave
1918-1921. W. C. Allee

Secretary

1921. W. C. Allee

Treasurer

1921. D. H. Tennent

LIST OF PLACES OF MEETING

AMERICAN MORPHOLOGICAL SOCIETY

1890—Boston	1894—Baltimore	1899—New Haven
1891—Philadelphia	1895—Philadelphia	1900—Baltimore
1892—Princeton	1896—Boston	1901—Chicago
1893—New Haven	1897—Ithaca	1902—Washington
	1898—New York	

CENTRAL NATURALISTS

1899—Chicago 1900—Chicago

SOCIETY OF AMERICAN ZOÖLOGISTS

1901—Chicago 1902—Washington

AMERICAN SOCIETY OF ZOÖLOGISTS

EASTERN BRANCH

1903—Philadelphia
1904—Philadelphia
1906—New York
1907—New Haven
1909—Boston
1910—Ithaca

JOINT MEETINGS

1905—Ann Arbor
1908—Baltimore
1911—Princeton
1912—Cleveland
1913—Philadelphia

CENTRAL BRANCH

1903—St. Louis
1905—(Mch.) Chicago
1907—(Mch.) Madison
1907—Chicago
1910—(Apr.) Iowa City
1910—Minneapolis
1912—(Apr.) Urbana

AMERICAN SOCIETY OF ZOÖLOGISTS

MEETING PLACES

1914—Philadelphia
1915—Columbus
1916—New York

1917—Minneapolis
1918—Baltimore

1919—St. Louis
1920—Chicago
1921—Toronto

AMERICAN SOCIETY OF ZOÖLOGISTS

OFFICERS AND LIST OF MEMBERS¹

Officers for 1922

<i>President</i>	H. H. WILDER
<i>Vice-President</i>	BENNET M. ALLEN
<i>Secretary</i>	W. C. ALLEE
<i>Treasurer</i>	D. H. TENNENT

Executive Committee

	<i>Term expires</i>
M. M. METCALF.....	1922
GEORGE LEFEVRE.....	1923
C. M. CHILD.....	1924
GILMAN A. DREW.....	1925
CHARLES A. KOFOID.....	1926

Representatives of the Society in the Division of Biology and Agriculture of the National Research Council

	<i>Term expires</i>
F. R. LILLIE.....	1923
H. S. JENNINGS.....	1924
G. H. PARKER.....	1922

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¹ The data given in this list is based on the last preceding list published in *The Anatomical Record*, Vol. 20, No. 2, with such corrections and additions as have come to the attention of the Secretary. Please notify the Secretary of errors in this copy of the membership list that they may be corrected in the next published list.

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AN ANOMALOUS ARTERIAL SUPPLY TO SUPRARENAL, KIDNEY AND OVARY

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TWO FIGURES

Anomalous blood vessels are always interesting from a purely scientific point of view, especially since they so often shed light on obscure problems of phylogeny and ontogeny. They may also be of considerable significance from a clinical or surgical standpoint.

Variations of the suprarenal and renal arteries occur very frequently, and anomalies of the ovarian or internal spermatic arteries are not uncommon. The cause of the extreme variability of these blood vessels is found in their embryonic history, and since they are derived from a common source (Broman, '06, '07; Bremer, '15), all combinations of the several vessels are to be expected. The anomalies in the specimen described in this paper illustrate rather nicely some phases of arterial development as outlined by Bremer ('15) in his discussion of the origin of the renal artery in mammals.

DESCRIPTION

The subject of the present description was a well-proportioned, full-term human fetus (female). The anomalies noted were discovered during the regular dissection in the course in infant and fetal anatomy and the body was put aside for further study. Apart from the variations to be discussed in detail here, the specimen exhibited several other important arterial anomalies. There was no right innominate artery. The right subclavian artery arose as the last branch from the left extremity of the arch of the aorta and passed obliquely toward the right side,

behind the trachea, oesophagus and right carotid. The two common carotids were united into a very short single trunk. In addition to this, the right umbilical artery was absent. This last anomaly is important, since a single umbilical artery is usually associated with fusion of the lower limbs (sympodia), and it will be described elsewhere.

The inferior phrenic arteries arose from the coeliac axis. They appeared relatively large and each gave off several small branches (superior suprarenal) to the suprarenal gland of its own side. (The course of the arteries is not shown in figure 1, as the glands are pulled upward to show other details of the circulation.) The right middle suprarenal was comparatively small. In the fetus it usually approximates the renal artery in size. It arose directly from the aorta. The left middle suprarenal artery arose from an accessory renal artery.

The arterial supply to the right kidney arose from the aorta as a single trunk, but soon divided into two vessels of almost equal size. The superior division (an accessory renal artery) gave off almost immediately a small suprarenal branch, which has been designated the inferior suprarenal, although other suprarenal branches arose from this same division of the renal trunk. After giving off the inferior suprarenal branch, the accessory renal artery ran but a short distance when it was divided into two branches, forming a superior and an inferior division. The superior branch ran upward to the suprarenal gland by way of an arterial plexus and terminated in four slender branches. The arterial plexus with which it communicated sent branches also into the dorsal musculature, the right psoas major muscle and the right crus of the diaphragm. The inferior branch of the accessory renal artery also terminated in the suprarenal gland, but it passed over the anterior superior surface of the kidney and sent at least eight branches into the renal tissue. The inferior division of the main renal trunk, the normal renal artery, entered the kidney at the hilus.

The arterial supply to the left kidney also arose from the aorta as a single trunk. It soon divided, however, into three main branches, a superior, a middle, and an inferior. The

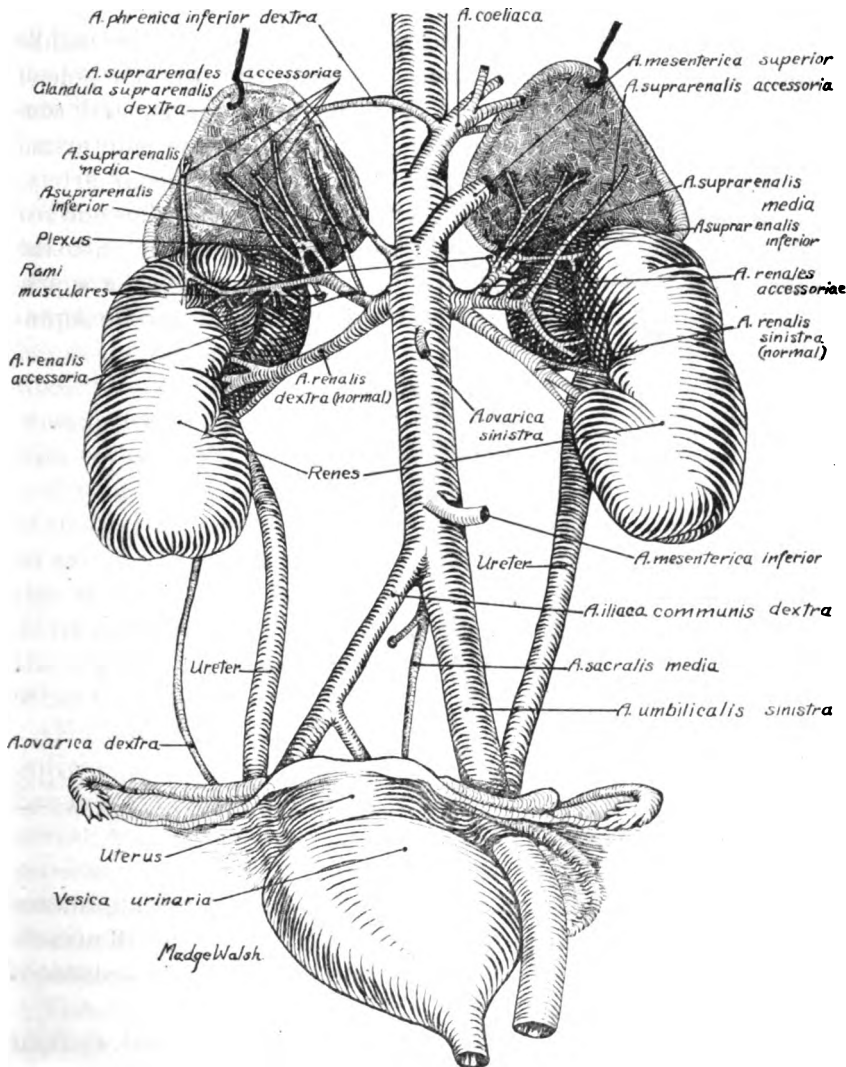


Fig. 1 Semidiagrammatic drawing of the abdominal aorta and its main branches (viewed from in front), showing the anomalous arterial supply to the suprarenal glands, kidneys, and right ovary. The suprarenal glands are pulled upward off the superior poles of the kidneys. Note the single umbilical artery (left) and the lateral displacement (to the right) of the uterus and urinary bladder.

inferior branch was the largest and entered the kidney at the hilus. It corresponds to the normal renal artery. The middle branch, an accessory renal artery, passed to the superior pole of the kidney, sent two branches into the renal tissue, and continued on to the suprarenal gland as an accessory suprarenal artery. The superior branch, also an accessory renal artery, divided irregularly into several branches. Two branches entered the kidney at its superior pole; two passed dorsally into the musculature of the body wall and two others supplied the suprarenal gland. Since, on the left side, there was no middle supra-

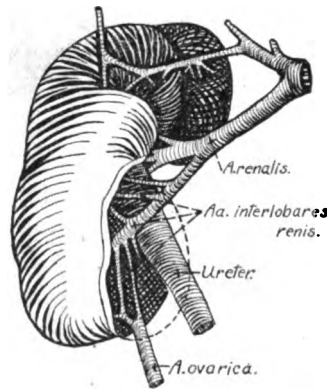


Fig. 2 The right kidney, ventral view, with the medial half of the inferior pole dissected away, to show the connections between the anomalous ovarian artery and the interlobar renal arteries.

renal arising directly from the aorta, the first of the suprarenal branches was regarded as the middle suprarenal, and in accordance with this interpretation the second branch was designated the inferior suprarenal artery.

The right ovarian artery exhibited by far the most striking variation. It arose from the renal artery, but, unlike the variations previously described in which the ovarian arteries were given off before the kidney was reached, the artery in this case was given off within the kidney, being formed by the union of three branches from the interlobar renal arteries (fig. 2). It emerged from the inferior pole of the kidney (fig. 1), and its

course and relations beyond the kidney were practically the same as for the normal artery. The left ovarian artery arose from the ventral surface of the aorta a short distance below the renal arteries.

EMBRYOLOGICAL SIGNIFICANCE

There is not complete unanimity regarding the embryological history of the arterial supply to the suprarenal glands, kidneys, and sex glands. Broman ('06, '07) derives the arteries supplying these organs from the mesonephric arteries. Bremer ('05), however, disagrees, partially at least, with Broman's account. According to Bremer, the arteries are developed from 'an anastomosing periaortic net having many connections with the aorta.' This net or plexus usually unites dorsal segmental, mesonephric, and ventral arteries. Bremer also points out that the history of this development differs in different mammals, being influenced in man by the lesser curvature of the rump region, the small size of the wolffian body, and the early appearance and rapid development of the suprarenal gland, the result being that in man the suprarenal gland primarily receives the vessels which in other mammals go to the kidney.

Of these numerous anastomosing arteries, only three survive ordinarily. An ascending branch from the uppermost usually becomes the inferior phrenic artery, a descending branch of the lowest becomes the normal renal artery, while the middle one persists as the middle suprarenal artery. Whether or not the normal channels are to be utilized is probably determined mechanically to some extent. If the normal course is blocked, other more devious paths may be followed.

The relations, described here of the accessory arteries to the kidneys and to the suprarenal glands, and the anastomosing connection within the kidney between the normal renal arterial supply and the ovarian artery, support Bremer's claim of an early periaortic net.

Additional evidence in favor of this view is found in three cases (IV, VI, and IX) of anomalous renal arteries described by Gillaspie, Miller, and Baskin ('16). In case IV, a left acces-

sory renal artery was given off from the superior mesenteric artery. In case VI, one of the four large-sized renal arteries supplying the right kidney arose from the coeliac axis. These cases indicate an early connection between the lateral and ventral aortic branches.

In case IX the main renal trunk on the right side was connected with the aorta by a plexus of vessels of varying sizes, and on the left side two small arteries came from a plexus which resembled the periaortic plexus. The varying arterial plexi noted can be regarded as examples of local persistence of the early anastomosing periaortic net. That these connections must be 'early' and not 'late' or secondary is shown by Bremer, since they can only be formed from vessels present in the embryo before the aorta and its larger branches develop mesodermal coats (10- to 12-mm. embryos). Towards the close of his paper Bremer ('15) states: "Dorsal connections of the suprarenal arteries with the body wall or with the true dorsal segmented arteries can be conjectured as a persistence or extension of the plexus." His conjecture is realized in the fetal circulation described, since part of the abnormal suprarenal supply was linked with a plexus which sent branches into the dorsal body wall.

SUMMARY

Anomalous arteries, found in a full-term human fetus, are discussed in this paper. Arising from the 'normal,' right, renal artery which entered the kidney at its hilus, there was an accessory renal artery, which, after giving off two suprarenal branches, passed over the anterior superior surface of the kidney, sent eight branches into its tissue, and terminated finally in the suprarenal gland. The first suprarenal branch was regarded as the inferior suprarenal artery. The second branch joined an arterial plexus, from which four slender suprarenal branches arose. From this plexus branches were also given off to the dorsal musculature.

The left renal trunk was divided into three branches. The inferior branch entered the kidney at the hilus. The middle and superior branches, accessory renal arteries, supplied the superior pole. The middle renal branch sent an accessory branch to

the suprarenal gland. The superior renal branch sent two branches to the suprarenal gland (middle and inferior suprarenal arteries), and two branches into the dorsal musculature.

The right ovarian artery arose within the kidney, being formed by the union of several branches from the interlobar renal arteries, and after emerging from the inferior pole of the kidney pursued a normal course.

These anomalies are interpreted as supporting Bremer's claim of an early periaortic plexus from which the renal, suprarenal, and sex-gland arteries are derived.

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Resumen por el autor, W. E. Sullivan.

La anatomía de una mano sindáctila.

La mano estudiada presenta una unión completa de los dedos mediante membranas y una fusión parcial de los elementos óseos. Los carpianos están reducidos a seis, los metacarpianos a cuatro y las falanges a siete. Los músculos más modificados son los flexores largos; los lumbricales, que faltan; los interóseos, de los cuales hay solamente uno. Las inserciones de los flexores largos han emigrado proximalmente hasta transformarse en flexores de la muñeca. Las modificaciones musculares y óseas están relacionadas parcial, no completamente. Elementos fibrosos tienden a sustituir a los elementos óseos ausentes. La condición vascular, aunque no es la ordinaria, pudiera presentarse en una mano normal. La distribución de los nervios está relacionada directamente con otras modificaciones. La extirpación de los dos dedos intermedios aumentaría la utilidad de la mano.

Translation by José F. Nonidez
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THE ANATOMY OF A SYNDACTYLOUS HAND

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ONE FIGURE

The hand in question may be referred to as brachydactylous as well as syndactylous, for there is a reduction of one phalanx in each digit in addition to the webbing and fusion. It is the right hand of a male laborer about forty years old. The left hand is normal. Nothing is known of the family history.

The general shape of the hand is sufficiently indicated by the radiograph. The volar surface is unbroken and there is no indication of separate digits. The thenar and hypothenar eminences are well marked. The thenar eminence is slightly reduced, but the hypothenar would equal the average normal elevation. The skin is thick, creased, and calloused and indicates a serviceable hand.

On the dorsal surface the presence of separate digits is suggested by three well-defined nails. These three nails are fairly indicative of the internal condition. The x-ray shows part of a fourth digit and suggests that there are five terminal phalanges. Dissection shows more clearly that there are five terminal phalanges.

In the discussion it seems best to refer to the digits as the radial, radial intermediate, ulnar intermediate, and ulnar in the order indicated. From the relations found on dissection it was interpreted that the radial digit represents the first and second digits, the radial intermediate, the ulnar intermediate, and the ulnar represent the third, fourth, and fifth digits, respectively.

MODIFICATION OF THE BONES

The bones of the forearm show little if any modification. The distal end of the radius is slightly enlarged.

Six carpal elements are present. These are interpreted as representing the ossa naviculare and lunatum in the proximal row, the multangulum majus, capitatum, pisiforme, and triquetrum in the distal row. The position and articulations of the several bones are seen in the radiograph. It may be pointed out that the distal end of the navicular overlaps the volar surface of the greater multangular. The os multangulum minus is absent. The os capitatum is greatly modified and corresponds to the proximal portion of the normal bone. The condition of the last two bones is in line with the general modification of the second and third digits. The os pisiforme is much flattened and somewhat larger than is usual. The os triquetrum is the name given to the large medial bone of the distal row. Its position and articulations as well as its size and shape indicate that it is the result of the fusion of the triquetrum and hamatum. The hamulus is much reduced.

The metacarpals show a considerable range of modification. The radial metacarpal is normal at its proximal end, but at the distal end presents two large articular surfaces, somewhat separated by a ridge, for the phalanges, and a small volar facet for a sesamoid.

The metacarpal of the radial intermediate digit is represented proximally by a small, ovoid, bony element. This bony element is imbedded in a wedge of fibrous tissue which has its base against the capitate and which, at its distal end, is connected with the phalanx by a round ligament more than a millimeter in diameter.

The two medial metacarpals are fused at their proximal ends. At the distal end each presents an articular surface for its phalanx.

In addition to the loss of one phalanx in each digit, there are one or two interesting modifications. The radial phalanx is large and irregular and is formed by the fusion of two terminal phalanges. The proximal end has two distinct articular surfaces, well separated by a groove. The more medial lies some-

what dorsad. On the dorsal surface the individuality of the two phalanges is clearly seen. The fact that the radial digit is equal in length to the other digits naturally suggests that there has been a fusion of the proximal and distal phalanges rather than the loss of a phalanx. There is nothing in the structure of the phalanx to indicate that this has been the case.

The proximal phalanx of the radial intermediate digit represents only the distal end of a phalanx, but, as already pointed out, it is joined to the metacarpal by a heavy ligament. The proximal phalanx of the ulnar intermediate digit is fused with its metacarpal and is somewhat longer than the other phalanges.

MODIFICATION OF THE MUSCLES

The forearm is well developed and at the elbow is but slightly smaller than its fellow. The muscles inserting on the radius and ulna are not modified. Those having a more distal insertion may be best discussed individually.

The palmaris longus, palmaris brevis, and flexor carpi ulnaris are normal.

The thenar muscles as a group are fairly well developed and arise from the lateral half of the transverse carpal ligament. The deeper fibers insert into the metacarpal. The more superficial fibers separate into two bundles to insert in part mediad and in part laterad on the volar surface of the base of the phalanx. The innervation suggests the absence of the adductor pollicis.

The hypothenar muscles are better developed than the thenar group. They arise from the pisiforme and medial half of the transverse carpal ligament and insert into the metacarpal and proximal phalanx. All of the hypothenar muscles are present.

But one interosseous muscle is present. It is a poorly developed volar interosseous of the ulnar digit.

The flexor digitorum sublimis is relatively small and ends in two small tendons which insert into the capitate and hamate. In addition, the tendons of the sublimis and profundus converge to form a common tendon of insertion into the distal row of carpals and the bases of the metacarpals. It acts only as a flexor of the wrist-joint.

The flexor digitorum profundus is of normal size. It goes over for the most part into the common tendon with the sublimis, but sends one tendon to the proximal phalanx of the ulnar digit. This tendon gives flexion and adduction at the metacarpophalangeal joint. The muscle as a whole acts as a flexor of the wrist-joint.

The lumbricals are absent.

The flexor carpi radialis inserts into the radial metacarpal.

The extensor carpi radialis longus inserts on the dorsum of the base of the radial metacarpal. The extensor carpi radialis brevis is absent.

The extensor digitorum communis has two tendons of insertion. The lateral tendon inserts on the phalanx of the radial digit. The medial tendon lies in the plane of the ulnar intermediate digit and for the most part inserts into the metacarpal. In addition it sends a slip to the radial intermediate metacarpal and a larger slip which attaches rather loosely to the dorsum of the ulnar metacarpal.

The abductor pollicis longus inserts into the lateral surface of the base of the radial metacarpal. Just dorsal to this is the insertion of the extensor pollicis brevis.

The extensor pollicis longus has an origin corresponding to the combined origin of itself and the extensor indicis proprius. It inserts into the terminal phalanx of the radial digit well toward the lateral margin.

The extensor digiti quinti proprius inserts into the proximal phalanx of the ulnar digit.

VARIATIONS IN THE ARTERIES

The ulnar and interossei vessels supply the forearm and hand. The radial artery is absent, while the volar interosseous is much enlarged. Such a condition might occur in an otherwise normal hand, and it is perhaps unwise to correlate it with the other factors.

There is but one volar arch which is formed largely by the ulnar, but which is completed by a perforating branch from the volar interosseous. The terminal branches of the volar interosseous supply the dorsum of the wrist and hand.

NERVES

The cutaneous distribution of the nerves showed nothing beyond the usual range of variation. On the dorsum of the hand they may be traced farther distally on the terminal phalanx than is usually possible on a normal hand.

MOVEMENTS AT THE SEVERAL JOINTS

The radiocarpal and carpometacarpal are biaxial joints. The movements in the former are normal. In the latter flexion and extension are possible through a range of about 80°, but abduction and adduction are modified in several ways. The fusion of the bones in the two medial digits as well as the general webbing restrict the movements. Splitting the hand and removing all of the ulnar intermediate digit except the base of the metacarpal added greatly to the range of forced movement.

SUMMARY

Muscular and osseous modifications are partially but not completely correlated. Fibrous elements tend to take the place of absent bony elements.

The vascular condition, while unusual, might occur in a normal hand.

The distribution of the nerves is directly correlated with the modification of the other structures.

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PLATE 1

EXPLANATION OF FIGURE

Radiograph of a right hand. In the text the digits are referred to as radial, radial intermediate, ulnar intermediate, and ulnar.



Resumen por el autor, Warren H. Lewis.

¿Es el mesenquima un sincicio?

Una revisión de la literatura referente al mesenquima considerado como un sincicio no ha revelado una sola prueba sobre la fusión de los procesos celulares, produciendo continuidad citoplásmica. En material fijado es imposible decidir si se trata de una adhesión o de una fusión. Los crecimientos del mesenquima embrionario en cultivos de tejidos procedentes de embriones de pollo forman un retículo semejante al que se observa en el embrión. Puede seguirse la lenta emigración de las células, la retracción de los procesos de las células vecinas y la producción de nuevos procesos en la misma o en otras células. Las células con muchos procesos pueden aislarse completamente de todas las demás células del retículo y, sin embargo, no se comportan de un modo diferente del de las células que forman aquel. Los procesos adheridos al cubre objetos se comportan lo mismo que los que se insertan en células vecinas, con la excepción de que los primeros se adhieren más firmemente. No existe prueba alguna sobre la transferencia de material alguno desde unas células a otras. Si se añaden soluciones hipertónicas a los cultivos, las células se transforman en redondas, perdiendo toda conexión con las células vecinas. En un tipo de degeneración se produce un efecto algo semejante. Las células hijas no permanecen fusionadas de un modo permanente sino que finalmente se encuentran en la misma relación que las demás células del retículo, o hasta pueden perder toda conexión. Las pruebas obtenidas mediante el estudio de los cultivos indica que el mesenquima embrionario es un retículo adherente y no un sincicio.

Translation by José F. Nonides
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IS MESENCHYME A SYNCYTIIUM?

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FOUR FIGURES

Many anatomists consider the mesenchyme a syncytium. They believe there is actual fusion of process with process, continuity of the cytoplasm, and absence of cell boundaries. In ordinary preparations of embryonic and adult material such fusion of cell processes appears to exist; but is this sufficient evidence upon which to base a distinction between actual fusion and mere adhesion? If one stops to consider the extreme delicacy of such processes in the embryonic mesenchyme, one must admit that here, at least, the methods used have not been adequate to settle the question. In fixed material it is simply impossible to tell whether there is fusion or adhesion. A review of the literature dealing with mesenchyme as a syncytium has not disclosed to me one single instance of actual proof that mesenchyme really is syncytial in nature. It is a question which cannot be solved by the methods now employed. The idea that mesenchyme cells are fused together dates back at least as far as the time of Max Schultze ('61),¹ and from that time to the present this view seems to have prevailed among the majority of investigators who have studied the origin and development of the connective tissues. No special effort has been made in the past to prove this particular point, for the reason, I suppose, that ordinary sections appeared to show clearly that the cells were fused, and so it seemed too much a matter of fact to call for a special investigation.

In the early days of tissue culture we used the term 'syncytium,' adopting the prevailing view of the nature of this tissue,

¹ Schultze, Max. 1861 Ueber Muskelkörperchen und das, was man eine Zelle zu nennen habe. *Archiv. f. Anat. und Physiol. Reichert.*

since the outgrowths resemble in general character the tissue as it exists in the embryo. From the behavior of such cells in tissue cultures, however, I have gradually come to doubt the correctness of the view that the mesenchyme is syncytial in nature, and it is my purpose here to present briefly the evidence.

The cultures utilized in the study were all from embryonic chick material of various organs and regions, for the most part from the subcutaneous tissue. They were made in the usual manner with fluid media consisting of Locke's solution 80 parts, dextrose 0.25 to 0.5 per cent, and chicken bouillon 20 parts.

The general appearance of the mesenchymal reticulum in the more normal cultures is strikingly similar to that in the embryo, and there is no reason to believe that the nature of the attachment of one cell to another is different in the cultures from that in the embryo.

The first cells that migrate out often become entirely isolated from the explant and from one another, but as the number increases they crowd together, and a complicated reticulum, similar to that in the explant, is formed in the outgrowth. Thus it would seem that the early migrating cells have no difficulty in becoming entirely isolated from the reticular network in the explant of which they were a part, by forces which pull or force them out.

It has been assumed by many that the mesenchymal syncytium was brought about in part, at least, by the failure of the cytoplasm to divide completely after division of the nucleus. We have often observed a lingering connection between daughter cells for an hour or more after division. Many daughter cells, however, ultimately move some distance apart and the character of their attachment is then no different from that between these and neighboring cells.

In living cultures in fluid media the outgrowths of mesenchyme, as well as of most other types of cells, tend to be forced by the conditions of the environment into a single plane lying between the cover-glass and the fluid. The cell bodies, of course, project down into the fluid, but this becomes less and less marked as the cells flatten out more and more towards the

periphery of the outgrowth. Near the explant the cells are often more than one layer thick and their behavior, therefore, cannot be successfully observed; but the conditions at and near the periphery, or even in the middle of the outgrowth, afford an unusual opportunity for examining the relationship between the processes of one cell and the processes and bodies of neighboring cells (figs. 1 and 2). At the periphery the cells not only are more flattened, but usually become more widely separated and even entirely isolated from neighboring cells. In this region one can watch the slow shifting of cells from one position to another and can follow the withdrawal of processes which were adherent or in contact with the processes or bodies of neighboring cells. There is no reason to believe that such processes were previously fused with the processes or bodies of the neighboring cells, even though it is usually impossible to determine this by observation. In the slow withdrawal of the processes there is usually no evidence of a rupture. Many of the processes end on the cover-glass; except for the fact that they are more firmly adherent, there is apparently no difference in character between these processes and those attached to neighboring cells, and their withdrawal or change of shape proceeds in a similar manner. Simultaneously to the withdrawal of processes from neighboring cells or from the cover-glass, new processes are sent out along the cover-glass to the same cells or other cells and to other positions on the cover-glass. As cells become separated more and more at the periphery they may lose all connection with neighboring cells, their processes extending out and ending on the cover-glass. Such cells behave no differently from those forming part of the reticulum. This shifting of the relative positions of cells and of the area of attachment of their processes, and the changes in the size and shape of these areas of attachment, all indicate adhesion rather than fusion.

It is not uncommon, in cultures that have just been washed with a new solution of one kind or another, to find that the mesenchyme cells are drawing in their processes and losing connection with the neighboring cells and with the cover-glass. Such contraction may proceed until all connections with neigh-

boring cells are lost; it may even be so extreme that the cells lose their adhesion to the cover-glass, when the rounded cells may fall from the under-surface of the cover-glass to the lower surface of the drop. If, however, the cells retain their attachment to the cover-glass, they may later send out new processes onto the cover-glass, some of which may find their way to neighboring cells and their processes, and a reticulum is again established. Sometimes contraction is so violent that here and there processes are broken, the peripheral end remaining attached to a neighboring cell or the cover-glass, the proximal part withdrawing into the cell. Sometimes the mere transfer of the slide from the incubator to the warm observation box is sufficient to produce withdrawal of processes and more or less rounding up of the cells.

Hogue ('19)² found that when cultures of mesenchyme cells were treated with hypertonic Locke-Lewis solution, many of them withdrew their processes, became irregularly rounded, and lost connection with other cells, since all processes disappeared. Mrs. Lewis ('20)³ found that in cultures of smooth muscle a minute amount of glycerin introduced into the neighborhood of the growth caused all cell processes to be immediately withdrawn, so that the cells became isolated individuals and remained so for several hours after the abnormal environment had been removed.

We should hardly expect cells to behave in this manner if they were actually fused together, though of course one cannot deny the possibility that they might do so, even under that condition. The mode of withdrawal of the processes in the rounding up of cells, however, indicates adhesion. When processes withdraw into the cell body, the line of separation does not come in the intermediate area between the bodies, but the processes seem to slip off from each other or from the cell bodies, just as they do when they are withdrawn under more normal conditions.

² Hogue, M. J. 1919 The effect of hypotonic and hypertonic solutions on fibroblasts of the embryonic chick heart in vitro. *J. Exper. Med.*, vol. 30.

³ Lewis, M. R. 1920 Muscular contraction in tissue cultures. *Contributions to Embryology*, vol. 9. Carnegie Inst. Wash., Pub. 272.

In one type of degeneration the processes are gradually withdrawn into the bodies of the cells and connections with neighboring cells disappear one after another until finally all connections are lost and many of the cells become entirely isolated from their neighbors. At the same time most of the processes which are attached to the cover-glass only contract into the body of the cell, and the latter assumes a more or less compact rounded shape (fig. 4). Such rounded cells may remain alive for some time and, if degeneration has not proceeded too far, a renewal of the medium may be followed by the sending out of new processes onto the cover-glass and to neighboring cells.

In fixed cultures, as in sectioned material, the network of processes in most places is so complicated that one cannot determine in the majority of cases whether the anastomoses are accompanied by fusion or by mere adhesion (figs. 1 and 2). Near the periphery, however, it is often possible to follow the outline of some very thin processes onto neighboring cells or processes of those cells, and it is not unusual for larger and longer processes to be followed over several neighboring cells (figs. 1 and 2). One cannot tell, of course, whether there is any fusion where such processes lie flat against other processes or cells in this fixed material, but the fact that under favorable conditions they appear to retain their individuality and their outlines can often be followed, in part or in their entirety, on neighboring cells, speaks against fusion. The difficulty in determining in all cases whether we are dealing with adhesion or fusion can readily be understood when we picture the conditions involved were an isolated cell such as that shown in figure 3 to be placed in such a complex network or reticulum as that shown in figure 1.

One interesting thing about the mesenchyme cells is the fact that they form in cultures a reticulum very similar to that in the embryo. Why do they behave thus and what are the factors that determine it? Why does the mesenchyme form a reticulum and the epithelium or endoderm a sheet or membrane? In the first place, we may safely conclude that the surface of the cells is sticky for each other and for the cover-glass, and that the physical factors of cohesion and surface tension or capillary attraction are constantly at work in altering the form

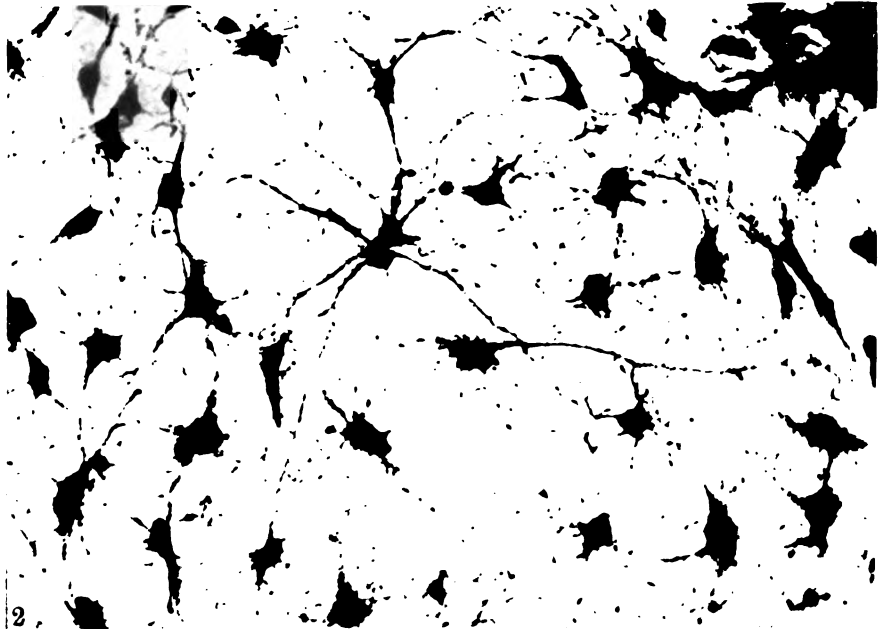
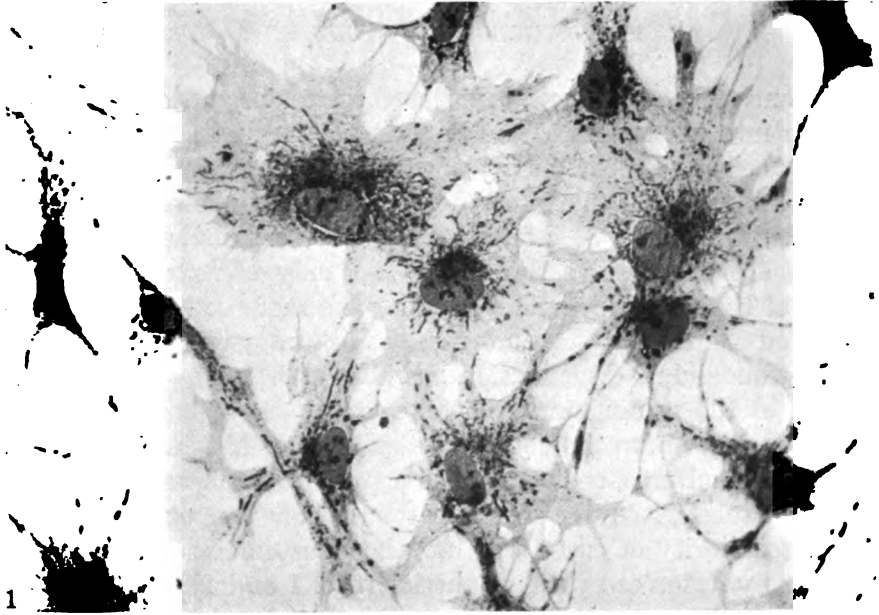
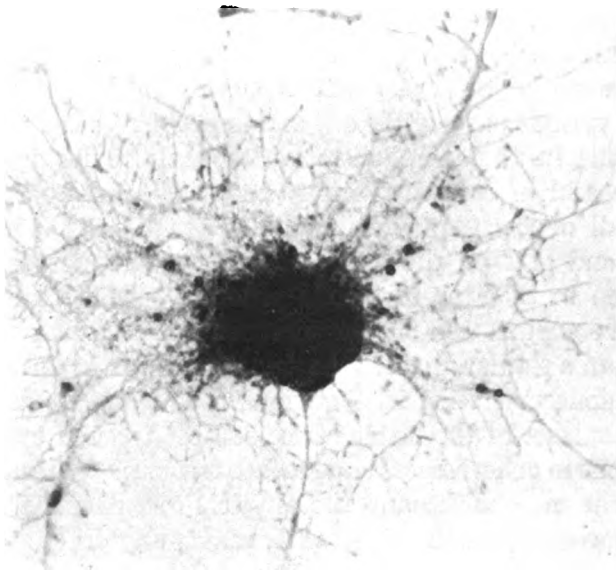


Fig. 1 Mesenchymal reticulum or network from the middle portion of the outgrowth of subcutaneous tissue from an eight-day chick embryo; two-day culture in Locke-Lewis solution; janus green, iodine. $\times 480$.

Fig. 2 Mesenchymal reticulum of subcutaneous tissue from an eight-day chick embryo; four-day culture in Locke-Lewis solution; janus green, iodine. $\times 480$.



3



4

Fig. 3 Isolated mesenchymal cell near the edge of the outgrowth from the same culture shown in figure 1. $\times 1450$.

Fig. 4 Contracting mesenchymal cells in a degenerating culture from the subcutaneous tissue of an eight-day chick embryo; four-day culture in Locke-Lewis solution; janus green, iodine. $\times 480$.

and position of the cells and their processes. Evidently, the cohesiveness of the cytoplasm is constantly undergoing alteration in various parts of the cell and is probably initiated by local variations in the metabolism which produce local changes in fluidity and in surface tension (Loeb, '20).⁴ The surface tension pull of the fluid medium bathing the cells is a constant factor and acts on the changing cells to produce shifting and variation in their protoplasmic processes. If we adopt such a tentative explanation for the mesenchyme cells and attempt to explain in a similar manner the smoother edges of the ectodermal and endodermal cells, it is obvious that we must assume that the cytoplasm of the latter is not subject to such extreme local variations in cohesiveness and surface tension. We know so little about the metabolism and the physical and chemical properties of the mesenchyme that it scarcely makes any difference whether we regard the mesenchyme as a syncytium or as an adherent reticulum. Yet the fact that such cells, both in cultures and in the normal embryo, retain their individuality, no two of them being exactly alike in size and shape, in number, or arrangement of their processes, in number, size, or arrangement of the mitochondria, in number, size, or position of the granules and vacuoles, or in the size and position of the nucleus and nucleolus, speaks for adhesion and for the independence of each cell. There is no indication of the transfer of material from one cell to another. We did believe at one time that mitochondria passed from one cell to another, but more critical examination of living cultures has convinced me that this is not true.

The development of the collagenic fibers, whether their origin be intercellular or intracellular, can be explained as readily from an adherent reticulum as from a syncytium.

CONCLUSION

There is no evidence that embryonic mesenchyme is syncytial in structure. The evidence from tissue cultures points to the view that it is an adherent reticulum or network, and not a syncytium.

⁴ Loeb, Leo. 1920 The movements of the amoebocytes and the experimental production of amoebocyte (cell-fibrin) tissue. Washington University Studies, vol. 8, Science Series no. 1.

Resumen por el autor, Sidney M. Cone.

Terminaciones de los nervios seccionados.

El presente trabajo comienza con una referencia al trabajo experimental de Cajal sobre la regeneración de los extremos de los nervios. El autor describe sus observaciones en el caso de nervios lesionados en heridas de guerra, en los cuales los corpúsculos de Pacini se formaron en el tejido subcutáneo de un muñón doloroso en un dedo amputado. Estos cuerpos han podido seguirse en su origen hasta un fascículo de nervios del callo nervioso vecino. El autor describe el corpúsculo de Pacini y su formación. También incluye una referencia al método de teñido.

Translation by José F. Nonidez
Cornell Medical College, New York

ENDINGS OF CUT NERVES

SYDNEY M. CONE

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ONE PLATE (FOUR FIGURES)

Cajal's recent article in the July number of the *Siglo Medico*, Madrid, describing the regeneration of nerve ends in experiments on animals, reports inability to obtain regeneration of end bodies of sensory nerves. The wild growth of embryonal nerves is noted, but he has not been able to demonstrate specialized end organs.

Among the many peculiar manifestations of new nerve growth following war injuries, in my collection, is one of pacinian bodies (Vater's corpuscles) in a finger stump. The ring-finger had been amputated, and a year later the stump was again removed on account of pain. The note made by me at the time of the microscopic examination calls attention to nerve callus following the nerve trunk and spreading in the subcutaneous tissue and scar. Numerous pacinian bodies were noted. The nerve callus does not differ from that which I found in all cases of war-injured nerves. The individual fasciculi, consisting of ten to twenty nerve fibers measuring 2 to 4 μ each, intertwine about the original nerve, passing beyond it to the loose subcutaneous tissue and into the stump scar. A few fasciculi break up into individual fibers at the formation of large, oval, lamellated bodies, varying in size from 60 to 150 μ long and 40 to 60 μ wide. Several capillaries of the fasciculus pass with the individual nerve fibers into the pacinian corpuscle and spread at the periphery. The nuclei of the Schwann sheath cells become even more than ordinarily elongated and flattened at the circumference, but three or four entire cells are demonstrated in the central core. The fasciculi, as they end at these bodies, are made up of elongated nuclei and varicose fibers (Peroncito's spirals). The

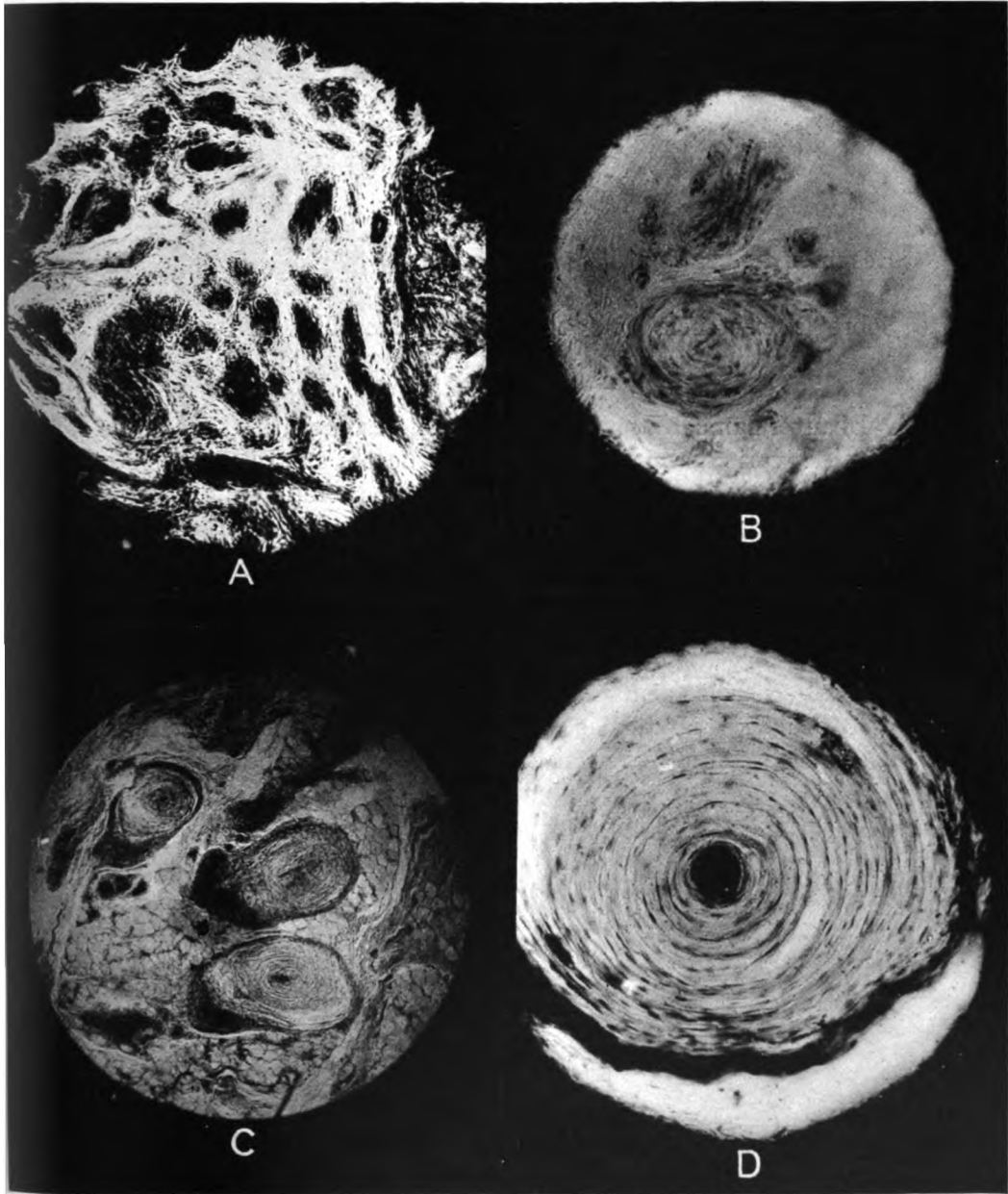
capillary vessels within the fasciculus pass into the body and also course round about the corpuscle. The nuclei are numerous and compressed between the flattened fibers. Indeed, one cannot tell the difference between the nucleus and axis-cylinder in these bodies any more than was it possible to distinguish nucleus and nerve in the embryonal fiber in nerve callus. The periphery of the body is made of thinner, more compressed layers than the center. A capsule of vascular connective tissue encapsulates the Vater corpuscle. In the center the Schwann sheath cell nuclei are swollen and well stained. There is no adult connective tissue in the bodies. The entire process looks like a swelling and rounding off of the new nerve callus tips in subcutaneous fat. These specimens were stained with the neurokeratin stain, described by me in the British Journal of Surgery, May, 1918.

I am greatly indebted to Prof. Hugh R. Spencer for the photographs.

PLATE 1

EXPLANATION OF FIGURES

- 1 Nerve callus about the cut digital nerve.
- 2 Fasciculus of nerve callus passing into the pacinian corpuscle.
- 3 Three pacinian bodies in subcutaneous fat.
- 4 Individual pacinian (Vater) corpuscle demonstrating stratified layers, capillaries and Schwann sheath cell nuclei.



Resumen por el autor, A. L. Salazar.

Sobre la existencia de falsos cuerpos amarillos autónomos en la glándula intersticial de la coneja.

El autor llama la atención acerca de la existencia, en el ovario del conejo (ovario de tipo intersticial), de cuerpos amarillos atréticos, con una evolución autónoma; estos cuerpos atréticos a diferencia de los ordinarios, no se amalgaman en la glándula intersticial, sino que pasan autonómicamente a través de su evolución propia, aislados dentro de una cápsula de tejido conectivo. El autor describe brevemente las características de los cuerpos atréticos autónomos, y admite la posibilidad de su confusión con viejos cuerpos amarillos genuinos, siendo probablemente esta confusión una de las causas de las opiniones contradictorias formuladas en relación con la regresión de los cuerpos amarillos verdaderos.

Translation by José F. Nonides
Cornell Medical College, New York

SUR L'EXISTENCE DE FAUX CORPS JAUNES AUTONOMES DANS LA GLANDE INTERSTITIELLE DE LA LAPINE

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ONE FIGURE

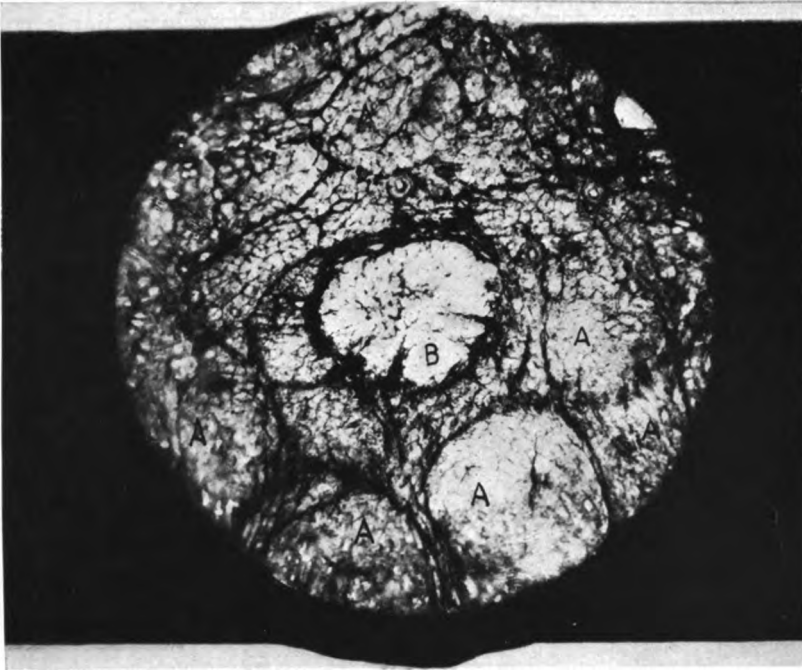
Limon, dans son travail¹ sur la glande interstitielle, dit que chez la Lapine "à la longue le faux corps jaune perd son individualité. Lorsqu'il ne reste plus de trace de la membrane de Slavjanski, il perd sa disposition arrondie. Il s'étire, s'aplatit transversamment." Cette description n'est pas absolument exacte; car, si quelques corps jaunes atrétiques s'aplatissent, s'étirent, au moment de leur fusionnement, d'autres conservent leur aspect arrondi; cela dépend des dimensions du follicule originaire, de leur position et d'autres circonstances, dont nous occuperons plus tard à propos de la formation du faux corps jaune. Ce que nous voulons signaler ici est que si la plupart des corps jaunes atrétiques perdent leur individualité et se fusionnent, quelques-uns conservent leur individualité pendant leur cycle, sans jamais se fusionner dans la nappe interstitielle. Nous les appellerons 'faux corps jaunes autonomes' pour les différencier de ceux qui se fusionnent dans la nappe interstitielle. Dans les coupes au tannin-fer les faux corps jaunes autonomes se reconnaissent facilement, même à de petits grossissements, grâce aux caractères suivants. Dès le moment de leur formation par atrésie folliculaire et hypertrophie de la thèque, ils s'entourent d'une épaisse coque conjonctive plus puissante que celle des faux corps jaunes habituels. Cette coque conjonctive accompagne le corps jaune atrétique autonome jusqu'au moment de sa

¹ Limon, Étude histologique et histogénique de la glande interstitielle de l'ovaire. Arch. Anat. Micr., T. 5, 1902.

disparition, tandis que la coque conjonctive des autres faux corps jaunes disparaît en partie au moment de leur fusion. Un autre caractère important des corps jaunes atrétiques autonomes est que la métamorphose adipeuse de leurs cellules débute dans le centre et de là irradie vers la périphérie. Il arrive un moment où toutes les cellules du faux corps jaune autonome se trouvent chargées de grosses boules lipoïdes. On voit alors le faux corps jaune autonome envahi par un tissu conjonctif puissant; cette invasion est due à l'effet convergent d'un envahissement conjonctif exogène et d'une prolifération endogène. Le conjonctif exogène vient de la coque conjonctive, accompagné de vaisseaux, qui en général se disposent en couronne dans la périphérie du corps jaune atrétique; le conjonctif endogène provient de la prolifération de la cicatrice conjonctive du follicule atrésié. De cette invasion conjonctive conjuguée avec la prolifération endogène il résulte la transformation du faux corps jaune dans un nodule cicatriciel. Cette transformation se fait grâce à un processus spécial, où le rôle actif appartient au conjonctif. En effet, on voit les fibres conjonctives énucléer les grosses boules lipoïdes qui font hernie dans les cellules. Les boules lipoïdes tombent ainsi dans le conjonctif qu'on trouve entièrement chargé de sphères lipoïdes. Certaines fibrilles conjonctives semblent être formées par les cellules interstitielles; ces faits sont à rapprocher de ceux que Mulon² a décrits dans le vrai corps jaune. Nous ne pouvons entrer ici dans les détails sur ce processus énucléateur. Les cellules présentent, dans leur évolution au dedans du faux corps jaune autonome, les mêmes caractéristiques générales que dans la nappe interstitielle: la lipogenèse s'y fait aux dépens du chondriome tannophile de la même manière. On y voit aussi de nombreux cristalloïdes. Il y a même des faux corps jaunes autonomes où prédomine la graisse, d'autres où prédominent les cristalloïdes. D'autres, enfin, sont caractérisés par la présence dans presque toutes les cellules d'un système de canalicules et lacunes étoilées. Nous ne savons rien sur la signification de ces différences; elles peuvent représenter diffé-

² Mulon, Sur un corps jaune kystique formé au dépens d'un ovisac non déhiscé. Arch. Anat. Micr., T. 11, 909, 910.

rentes étapes d'une même évolution cellulaire, ou des modalités structurales et fonctionales diverses. Nous n'avons pu non plus, jusqu'ici, observer nettement la destinée finale des cellules des faux corps jaunes autonomes; les faits observés par nous à ce propos sont assez contradictoires. Au moment de l'énucléa-



Ovaire de Lapine du type interstitiel cloisonné. A, A, A, corps jaunes atrétiques habituels; B, corps jaune atrétique à évolution autonome. Fixation, liquide de Bouin; méthode tanno-ferrique.

tion conjonctive des boules lipoides on voit entre les fibres collagènes des lambeaux déchirés de protoplasme interstitiel avec son aspect réticulé caractéristique; parfois on voit ici et là, dans les vieux corps jaunes autonomes des flots de petites cellules polyédriques très pauvres en protoplasme, ce qui semble indiquer que les cellules, après l'énucléation des boules lipoides, rentrent au repos. Mais ces faits ne possèdent pas la généralisation suffisante pour établir nettement la question. Les faux corps

jaunes autonomes sont habituellement ronds, les périphériques sont piriformes; après la prolifération conjonctive ces derniers semblent suspendus de l'albuginée par un puissant pédicule conjonctif. Nous avons observé un cas où ce pédicule était parcouru par un cordon épithélial qui naissait dans l'épithélium germinatif sous la forme d'une invagination, qui ensuite se transformait dans un cordon et pénétrait ainsi dans le pédicule conjonctif, où il se perdait. Certains corps jaunes atrétiques autonomes possèdent une coque conjonctive incomplète, en forme de croissant.

Il est bien possible qu'on ait confondu jusqu'ici les faux corps jaune autonomes avec les reliquats des vrais corps jaunes. Cette confusion peut expliquer jusqu'à un certain point les opinions si contradictoires qu'on a émises à ce propos. Nous ne pouvons cependant être affirmatifs à ce propos, car, presque toujours les travaux sont très pauvres en documents iconographiques sur les reliquats des vrais corps jaunes. Cependant, quand on étudie la littérature, on voit que les auteurs se partagent, à propos de la destinée du vrai corps jaune, en deux catégories absolument irréductibles. Pour les uns, les vrais corps jaunes participent dans la formation de la glande interstitielle, totalement,³ ou partiellement,⁴ pour les autres il subit une régression adipeuse et fibreuse. Or, les auteurs de la deuxième catégorie décrivent la régression de vrai corps jaune de telle manière, que leur description pourrait s'appliquer presque entièrement à l'évolution du corps jaune atrétique autonome. Ont-ils décrit, non des reliquats du vrai corps jaune, mais de vieux corps jaunes atrétiques autonomes? Nous l'ignorons, mais cela est probable. Cependant, on peut admettre une autre hypothèse, à savoir, qu'à partir d'un certain moment, le vrai corps jaune et le corps atrétique autonome présentent des caractères communs; seule, alors une étude minutieuse permettra de chercher les caractères différentiels. Conclusion: l'existence de corps jaunes atrétiques autonomes nous oblige à reprendre le problème, si obscur encore, de la destinée du vrai corps jaune.

³ Pfüger et V. Ebner.

⁴ V. der Stricht, etc.

Les faux corps jaunes autonomes n'existent pas dans tous les types d'ovaire; ils se montrent dans les ovaires du type interstitiel.⁵ Mais tous les ovaires de ce type ne présentent pas des corps atrétiques autonomes en nombre égal. Certains ovaires à type interstitiel non cloisonné,⁶ très volumineux, ayant dans la nappe interstitielle des champs de cellules interstitielles à type lutéinique, présentent de rares corps autonomes ou n'en présentent aucun; d'autres ovaires du type interstitiel cloisonné présentent de nombreux corps atrétiques autonomes. Ils semblent, donc, caractériser un moment donné de l'évolution de l'ovaire; mais cette question exige de plus amples recherches.

Jusqu'ici nous n'avons pas trouvé des différences cytologiques entre les cellules qui évoluent dans la nappe interstitielle diffuse et celles qui sont logées dans les corps atrétiques autonomes: chondriome tannophile, lipogénèse, cristallogénèse, système de lacunes et canalicules et d'autres caractères cytologiques de la cellule interstitielle se trouvent indifféremment dans les cellules de la nappe diffuse et dans celles des corps atrétiques autonomes. Cependant, nous n'avons pas pu faire encore un examen assez approfondi de ces deux types de cellules; il est probable que cette similitude ne soit qu'apparente et due à une connaissance superficielle des deux types cellulaires.

⁵ Sobotta, Regaud, Popoff, etc.

⁶ Pour cette nomenclature voir la note "Sur l'évolution de l'ovaire adulte de la Lapine." *Compt. Rend. de la Soc. de Biol.* No. 30, T. 85.

A TYPICAL PANCREATIC BLADDER DEVELOPED FROM AN ACCESSORY PANCREAS

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THREE FIGURES

Although the pancreatic bladder has been recorded at least fourteen times in the domestic cat,¹ it has never been ascribed to any other vertebrate. Even in the cat this anomaly is considered rare, since Johnson ('14) examined nearly four hundred specimens during a period of five or six years without finding an additional case. Miller, who found eight of the fourteen cases reported, suggests in extenuation of his good fortune that there exists a breed of cats in his locality among which pancreatic bladders are of relatively frequent occurrence.

An explanation of this anomaly was early provided through the discovery of two specimens which, although devoid of pancreatic bladders, exhibited accessory lobes of pancreatic tissue in the vicinity of the gall bladder (Miller, '04). In one case this band of pancreas arose from the duodenal division of the main pancreatic duct and extended along the bile duct as far forward as the gall bladder. In the other case there was a small truncated pancreatic mass in the fossa vesicae felleae which communicated with the duodenal division by means of a duct unaccompanied by glandular tissue. These findings were duplicated and extended by Heuer in 1906. Still later Miller ('10) found another specimen combining the two features, namely, a distal pancreatic bladder drained by a duct, the proximal half of which was embedded in a projecting lobe of pancreas. From an analysis of these specimens he concluded that the pancreatic bladder of the adult represents a persistence of the left

¹ See review of literature concluding this paper.

ventral pancreas, which undergoes an aberrant elongation in the direction of the gall bladder. According to this hypothesis, the terminal portion of the lobe becomes dilated, forming the bladder, and the proximal portion atrophies, leaving only a duct. Strong support for this explanation has been offered by Lewis ('11), who described the left lobe of the pancreas, in two pig embryos, as traveling across the ventral mesentery in the direction of the liver, instead of either disappearing, as is normal, or growing around the duodenum to form an infrequent anomaly—the annular pancreas.

The pancreatic bladder discussed in this paper is the second found by the author during the last year. The first of these, in one of twenty-five cats prepared for a class in comparative anatomy, agrees essentially with other cases previously reported. In every instance the aberrant duct arises either directly from the undivided portion of the ductus pancreaticus, or, in close proximity to it, from one of its primary divisions. The second case, found in one of a group of twelve class specimens, is radically different from any other hitherto described. As seen in figure 1, the duct of the pancreatic bladder empties directly into the duodenum some distance below the orifice of the duct of Santorini (*acc.d.*), and it has no relation to the ducts of either the dorsal or ventral pancreas. Throughout its course it is freely patent, and it opens into the duodenum through an orifice which is readily demonstrable, since it is not subdivided by folds such as occur in the cat at the ampulla of the main duct. In the proximal half of its course it is enveloped in a long, slender lobe of pancreatic tissue (fig. 1, *acc.pan.*) which it drains. This lobe is covered by the same peritoneal investment as the head of the pancreas, but is otherwise independent of the main gland from which it projects. As the duct emerges from the lobe, at its duodenal end, it is exposed for a few millimeters, but as soon as it reaches the wall of the intestine it is again enveloped, this time in a layer of fat, which probably represents a part of the original lobe which has here undergone fatty degeneration. In its distal half the duct is free from enveloping tissue. The bladder into which it leads is embedded in the right median lobe of the liver.

It lies to the left of the gall bladder, in which respect it apparently agrees with eight and differs from six of the cases reported. The terminal portions of the two bladders are separated from each other by a lobe of hepatic tissue, but lower down the two bladders are covered by a common fibrous capsule. Both bladders are supplied by branches of the cystic artery, the main trunk of which traverses an isthmus separating the pancreatic bladder into distal and proximal divisions.

In other respects the pancreas is normal; its dorsal and ventral portions are united by a bridge of tissue which completes the ring around the portal vein. According to Heuer, this bridge had formed in about 71 per cent of the cats he examined. The duct of Santorini (fig. 1, *acc.d.*) was present in this specimen and was studied histologically. During its passage through the wall of the duodenum it was found to give off short diverticula—a characteristic which it has in common with the corresponding region of the accessory duct in man. The lobe of tissue (fig. 1, *acc.pan.*) enveloping the duct of the pancreatic bladder was likewise sectioned, and was found to consist of typical pancreatic tissue, but, in the part examined, devoid of islands. It was supplied with branches of the superior and inferior pancreaticoduodenal vessels which penetrated the head of the pancreas to reach the under surface of this lobe.

Interest in this case lies chiefly in the light which it throws upon the origin of pancreatic bladders in general. Two possible modes of development have previously been advocated, the first of which has been discussed at the beginning of this paper. According to this view, a lobe of pancreas having a central duct and abortive alveoli, pushes its way out beneath the bile duct and forms a terminal cyst in close relation with the gall bladder. An alternative origin, suggested by F. T. Lewis, is through the subdivision of the hepatic diverticulum. So regarded, pancreatic bladders are extreme instances of double gall bladder (for which Miller in 1910 said that they might be mistaken), emptying into a subdivided cystic and common bile duct. "The inferior subdivision (pancreatic bladder) has lost its connection with the liver, but has retained its connection with the ventral

pancreas" (Lewis, quoted by Dresbach, '11). In support of this, the frequency of double gall bladders in the cat has been cited. Miller once found such a condition in a brother of a cat with a pancreatic bladder, and in a rather limited number of

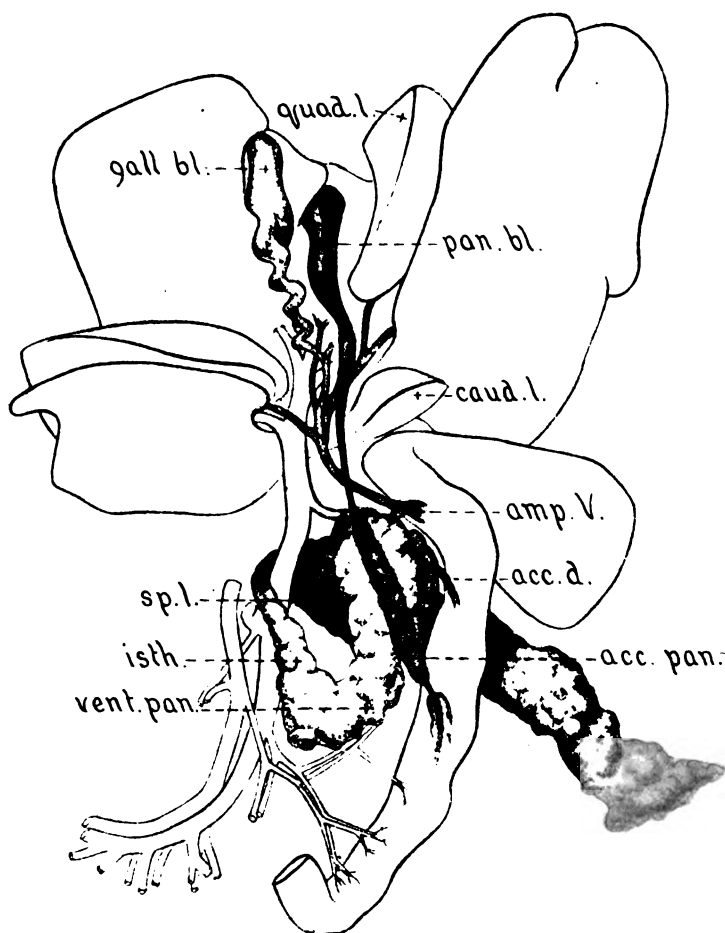


Fig. 1 Pancreatic bladder in a young female cat. *acc.d.*, accessory duct (Santorini); *acc.pan.*, accessory lobe of pancreatic tissue enveloping the duct of the pancreatic bladder; *amp.V.*, ampulla of Vater; *caud.l.*, caudate lobe of liver; *gall bl.*, gall bladder; *isth.*, isthmus connecting dorsal and ventral pancreases; *pan.bl.*, pancreatic bladder; *quad.l.*, quadrate lobe of liver; *sp.l.*, splenic lobe derived from dorsal pancreas; *vent.pan.*, ventral pancreas.

specimens examined a case was recently found by the writer. Notwithstanding certain difficulties which have caused this hypothesis to be discredited by Miller and Lewis, the similarity in structure of gall and pancreatic bladders and their close approximation render it attractive. There are certain cases to

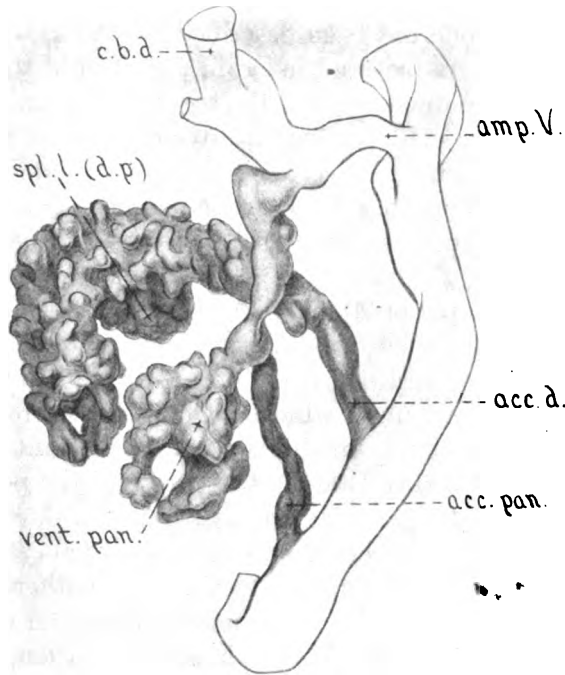


Fig. 2 Accessory pancreas in a pig embryo of 20 mm. $\times 55$ diam. H. E. C., series 60 (model by F. W. Thyng). *amp. V.*, portion of the bile duct from which the ampulla of Vater is formed; *c. b. d.*, common bile duct. See figure 1 for other abbreviations.

which it may apply, notably the one recorded by Miss Beckwith; and Professor Bremer, at the recent meeting of the American Association of Anatomists, has given new interest to this interpretation by modifying it and correlating it with pancreatic development in the rat. But in other cases, and notably in

the one under discussion, the hypothesis of divided gall bladder can be definitely eliminated.

Since the pancreatic bladder in the present case empties into the intestine below the normal hepatic and pancreatic outgrowths, it must have arisen from an anomalous accessory pancreas well down on the duodenum. Although accessory pancreases in this position have apparently not been recorded in the cat, a short one has been described by F. C. Mann ('20) in the adult dog.² As pictured in figure 1 of Doctor Mann's paper, it arises from the duodenum in the region of the duodenojejunal flexure and is directed toward the pylorus, thus corresponding rather closely with the accessory pancreas under discussion, but without terminating in a cystic enlargement. The early development of these anomalous pancreases has been observed in a few embryos, the most suggestive of which, in relation to the present case, is a pig of 20 mm. described by Lewis and Thyng.³ In this specimen, which was modeled by Doctor Thyng,⁴ from whose model a new drawing is here presented as figure 2, there is an accessory diverticulum which not only arises from the same relative position on the duodenum as the aberrant duct in the adult cat, but also travels along the course of the portal vein in the direction of the gall bladder, as far as the dorsal pancreas. It thus gives evidence of being a true accessory pancreas, destined, perhaps, to produce glandular alveoli. In another pig embryo discussed by Lewis and Thyng a similar but shorter diverticulum has become cystic, suggestive of bladder formation, but in that case the expanded terminal portion had become detached and was presumably in process of degeneration. From a study of these pig embryos, it seems probable that the aberrant diverticulum of the cat (fig. 1) represents a corresponding structure which has undergone further development, and having reached the liver has there become expanded into a bladder. Although

² Accessory pancreas in the dog. *Anat. Rec.*, vol. 19, p. 265, figs. 1 and 2.

³ The regular occurrence of intestinal diverticula in embryos of the pig, rabbit and man. *Anat. Rec.*, vol. 7, p. 508.

⁴ Models of the pancreas in embryos of the pig, rabbit, cat and man. *Am. Jour. Anat.*, vol. 7, p. 496.

originating as an accessory pancreas, from a primordium clearly distal in position to the normal pancreatic outgrowths, it has nevertheless duplicated the growth and transformation of the left lobe of the ventral pancreas in several of the cases of pancreatic bladder previously reported.

SUMMARY OF CASES

- 1815 MAYER, A. C. Arch. f. Anat. u. Phys., Bd. 1. Pancreatic bladder to right of gall bladder and smaller; duct terminates in trunk of ductus pancreaticus. This case was given considerable publicity. Cuvier (as noted by Lewis) described it in his *Leçons d'anatomie comparée*, 2^e édit., vol. 4, part 2, p. 587, Paris, 1835; and Owen, as Doctor Shaner informs us, repeats the description, referring it to Cuvier, but not to Mayer, in his *Anatomy of Vertebrates*, vol. 3, p. 496, London, 1868. No additional case, however, seems to have been recorded during an interval of sixty-four years.
- 1879 GAGE, S. H. Amer. Quart. Mic. Journ., vol. 1, p. 123. Pancreatic bladder to right of gall bladder and larger; duct terminates at the junction of duodenal and gastrosplenic divisions of the ductus pancreaticus.
- 1904 MILLER, W. S. Am. Jour. Anat., vol. 3, p. 269. *Three cases*: pancreatic bladder to left of gall bladder and, in two cases, smaller; duct opens into duodenal division of the ductus pancreaticus, 6 or 7 mm. from its junction with the gastrosplenic division. *Two cases* of pancreatic lobes paralleling the course of the ductus choledochus.
- 1905 MILLER, W. S. Anat. Anz., Bd. 27, S. 119. Pancreatic bladder to left of gall bladder and "of nearly the same size;" duct terminates in gastrosplenic division as above.
- 1906 HEUER, G. C. Johns Hopkins Hospital Bull., vol. 27, p. 106. *Two cases* of pancreatic lobes paralleling the course of the ductus choledochus.
- 1910 MILLER, W. S. Anat. Rec., vol. 4, p. 15. Pancreatic bladder below, to right of gall bladder and (in the figure) of nearly the same size; duct accompanied by pancreatic tissue terminating in duodenal division.
- 1911 DRESBACH, M. Anat. Rec., vol. 5, p. 365. Pancreatic bladder below, to right of gall bladder and smaller; duct joins other divisions in forming common sinus before entering ampulla.
- 1914 JOHNSON, C. E. Anat. Rec., vol. 8, p. 267. Pancreatic bladder to left of gall bladder and smaller; duct terminates at junction of two divisions of ductus pancreaticus.
- 1920 LARSELL, O. Anat. Rec., vol. 18, p. 345. Pancreatic bladder on the left of gall bladder and slightly larger; its main duct empties into the duodenal division. *Three additional cases*, obtained by Professor Miller, are here briefly described. (Two of these had been recorded, without description, by Dresbach, '11.) One was similar in all respects to Miller's second case in 1904 (pancreatic bladder on the left and smaller, emptying into duodenal division of pancreatic duct); the second case "corresponded with the one reported in 1905;" the third was similar to Miller's case of 1910.

1920 BECKWITH, CORA J. *Anat. Rec.*, vol. 18, p. 363. Pancreatic bladder to right of gall bladder and smaller; macroscopically, no trace of pancreatic tissue in connection with the pancreatic bladder or its duct; this duct opens directly into the ductus pancreaticus only 5 mm. from the place where the latter enters the duodenum close beside the ductus choledochus; differs from all previous cases by having an anastomosis between the duct of the pancreatic bladder and the cystic duct; since the cystic duct is occluded beyond the anastomosis, which is a large one, the pancreatic bladder was apparently functioning as a gall bladder. (For the measurement (5 mm.) and for confirming the correctness of this résumé by comparison with the specimen, still preserved in the laboratory of Vassar College, the writer is much indebted to Professor Beckwith.)

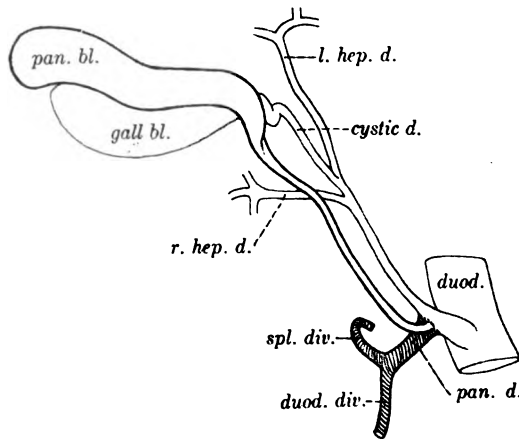


Fig. 3 Pancreatic bladder from a female cat. *duod.*, duodenum; *pan.bl.*, pancreatic bladder; *pan.d.*, pancreatic duct with splenic and duodenal divisions, *spl.div.* and *duod.div.*; *r.hep.d.*, *l.hep.d.*, right and left hepatic ducts; *cystic d.*, cystic duct; *gall bl.*, gall bladder.

The case reported by Miss Beckwith apparently belongs in the same class with the human double gall bladder recorded by Cruveilhier (*Bull. de la soc. anat. de Paris*, 1860, pp. 66, 67). The gall bladder which he described seemed to present merely a bifid fundus, but upon dissection it was found to be double as far as its neck. From the single neck two ducts were given off, one of which emptied into the hepatic duct. The termination of the other, very unfortunately, remains unknown, since it had been cut when the liver was removed at autopsy.

Even though the description is incomplete, it indicates that the specimen is essentially like Miss Beckwith's and that both should perhaps be removed from the group of pancreatic bladders. But if so, should not the following case, which is similar except that it lacks the anastomosis, be placed with them? It appears that the very different conditions of double gall bladder and true pancreatic bladder may be bridged in some instances by specimens which cannot be classified, since as yet a criterion for distinguishing them is not available.

1921 BOYDEN, EDWARD A. (the two cases reported in this paper):

Case 1. Pancreatic bladder to left of gall bladder and larger; its neck crosses that of the gall bladder, ventrally, to gain right side of bile duct; pancreatic bladder gray, empty, with walls thicker than those of the gall bladder; the walls of the two bladders fused throughout entire length and covered by a common fibrous capsule; cavities and ducts of two bladders not in communication with each other; duct of pancreatic bladder terminates in main stem of ductus pancreaticus, just before latter joins the common bile duct (fig. 3).

Case 2. Pancreatic bladder derived from accessory duodenal pancreas (for description, see text of this paper and fig. 1).

TOTAL NUMBER OF 'PANCREATIC BLADDERS' REPORTED

15 cases, derived either from an aberrant left lobe of the ventral pancreas or possibly from a subdivided gall bladder.

4 cases of an accessory lobe of pancreatic tissue paralleling the course of the ductus choledochus (which might be added to the above 15 as incomplete cases of pancreatic bladders).

1 case of pancreatic bladder derived unquestionably from an accessory duodenal pancreas.

Resumen por el autor, Shirley P. Miller.

Efectos de varios tipos de inanición sobre las mitocondrias del epitelio gastro-intestinal y pancreático de la rata albina.

La deficiencia en vitaminas y la inanición aguda pueden producir cambios en las mitocondrias de las células epiteliales gastro-intestinales y células glandulares del páncreas. La axfisia no produce aparentemente cambios tan marcados. La intensidad de la lesión sufrida por la célula debe ser muy grande para producir tales cambios. Cowdry ('20) ha llegado a las mismas conclusiones en sus experimentos sobre las raíces de las plantas.

Los cambios observados pueden consistir en: 1 (Una transformación de las mitocondrias bacilares en esféricas; 2) Una aparente reducción en el número de mitocondrias; 3) En la desaparición total de las mitocondrias de las células. A causa de la dificultad para obtener uniformidad en la técnica y las variaciones extremas observadas en las reacciones tintóreas, aún en las células normales, es evidente que debe observarse gran cuidado al derivar conclusiones con referencia a los efectos de los cambios del medio ambiente sobre las mitocondrias.

Translation by José F. Nonides
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EFFECTS OF VARIOUS TYPES OF INANITION UPON THE MITOCHONDRIA IN THE GASTROINTESTINAL EPITHELIUM AND IN THE PANCREAS OF THE ALBINO RAT

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Although there is an extensive literature upon mitochondria, the most of this is of a purely morphological nature. But few investigations have been made to determine their modification in number, size, or shape under experimental or pathological conditions. The observations of Lewis' ('15) would indicate that mitochondria are very labile and variable in their morphology. Changes in mitochondria have been described by Homans ('15) in pancreatic islet cells during diabetes; by Scott ('16) in the pancreatic cells of white mice in phosphorus poisoning; by Goetsch ('16) in thyroid cells during goiter, and by Cowdry ('20) in plant rootlets subjected to various harmful conditions. McCann ('18) observed persistence of mitochondria in the nerve cells of monkeys dying of experimental poliomyelitis. Rasmussen ('19) was unable to find any appreciable decrease in the mitochondria in the nerve cells of hibernating woodchucks. Russo ('12) found an increase in the amount of mitochondria in the oöcytes of rabbits during lecithin feeding. Apparently the only published observations on the effects of inanition upon the mitochondria are the results briefly stated by Schun Ichi Ono ('20) at a meeting of the Anatomical and Anthropological Association of China. He demonstrated histological preparations showing the effect of starvation upon the mitochondria in the somatic cells of *Ascaris*, causing them to become granular. He also observed altered size and shape of mitochondria in the tissues of starved rodents. Since further investigation of this question seemed desirable, the present study was undertaken in

order to determine the changes in the mitochondria of the gastro-intestinal epithelium and of the pancreas in the albino rat during various types of inanition. During the progress of this study, it seemed wise to have for comparison some material which had been submitted to other experimental conditions than types of starvation. Therefore, a number of rats were asphyxiated by suffocation.

MATERIAL AND METHODS

The thirty-four albino rats used in these experiments were all males except three. The age of the animals ranged from new-born to adult. Three animals were new-born, weighing 4 grams each. Two were mature adults with a weight of about 275 grams. The remainder were young adults weighing from 140 to 160 grams. All animals were weighed at the beginning and end of the experiments. The lengths of the body and the tail were taken at the time of death. The age of all animals was known. As far as possible, test animals and controls were from the same litter, and were killed at the same time. The animals subjected to starvation were killed in the advanced stages of inanition, most of them when the animal was near death.

The animals submitted to asphyxiation were placed on a glass plate and covered with a bell jar of about 1000 cc. capacity. The chamber was made air tight by means of vaselin spread around the juncture of plate and bell jar. Six to seven hours elapsed before the rats were asphyxiated.

The thirty-four rats were divided into the following groups: nine were given no food, but allowed water; one was given neither food nor water; one was a new-born and not allowed to nurse.

Through the kindness of Prof. J. F. McClendon, four rats were obtained which had been fed on diets deficient in water-soluble A vitamine in various degrees. I am likewise indebted to Prof. R. Adams Dutcher for two rats, one fed upon an exclusive diet of gelatin for thirty days and the other for the same length of time on an exclusive diet of zein. Seventeen normal rats were used as controls.

The tissues of both test rats and control animals were fixed in the same manner and simultaneously dehydrated and imbedded in paraffin.

Bensley's acetic-chromic-osmic and Regaud's formalin-bichromate fixers were used. Sections were cut 2 and 3μ thick, and mounted in a series of ten or twelve to a slide. In some cases test and control tissues were mounted on the same slide—a method which gave the same staining technique for each.

The sections were stained by the acid-fuchsin-methyl green method of Bensley.

OBSERVATIONS

At the outset it may be well to emphasize the great variation found in the form and number of mitochondria in both the test and control tissues, due in part to the difficulty in securing uniformity of technique. Not all the cells of the epithelium of the test animals exhibit the modifications which are described. There are areas in the epithelium in which the cells show evidence of necrosis as a result of injury due to experimental conditions. In such circumscribed regions mitochondrial changes in form and number were apparent, especially in the deeper portions of the mucosa.

The normal stomach. In the gastric glands the mitochondria of the chief cells are short, straight rods. In most of the cells one may also find spherical mitochondria, but only a few to a cell. The spherical forms present the appearance of having been separated from the rod-like forms. Occasionally there is a linear arrangement of such spheres, as if a whole rod had become segmented. The rods vary from 2 to 5μ in length and the spheres from five-tenths to eight-tenths of a micron in diameter. The mitochondria are in most cells uniformly distributed throughout the cytoplasm. In exceptional cases there is a peripheral condensation, or grouping of the mitochondria, chiefly at the base of the cell.

Because of the difficulty in distinguishing between the acidophile secretory granules and the mitochondria of the parietal cells, no special study was made of these cells. Satisfactory

results in case of these cells could be obtained only by the use of the intra vitam stains. The cells of the foveolae and the surface epithelium have distinctly more mitochondria in them than do those of the glands. The mitochondria are uniformly distributed throughout these cells, and the size of the mitochondria is very nearly the same as of those in the chief cells.

The stomach of test rats. A study was made of the stomach in four rats fed for periods from 89 to 105 days on a diet variably deficient in water-soluble A vitamine. The chief cells of the gastric glands, in areas evidencing injury, exhibit changes in the mitochondria. This is especially true in case the diet is markedly deficient in the vitamine. The rod-like forms of mitochondria are entirely lacking, although a few spherical mitochondria occur. The cytoplasm of such cells exhibits a fine vacuolization at the periphery towards the lumen of the gland. Occasionally one finds this vacuolization throughout the cell. In the surface epithelium and the gastric foveolae the mitochondria show no well-marked or constant changes.

In the gastric glands of the two rats which had been fed on a diet of gelatin or zein, no mitochondria were found in the chief cells of the rather extensive necrotic areas.

Similarly in the rats subjected to acute inanition and in the last stages of starvation, no mitochondria occur in the chief cells of degenerated areas. Even in areas not exhibiting marked degeneration there are few if any mitochondria to be noted.

The cells of the foveolae and the surface epithelium, in all the experimental rats mentioned above, do not show as marked changes in the mitochondria. In those of the acute starvation series the rods are replaced to some degree by spheres. In but very few cases was it possible to find marked changes in the mitochondria of the cells of the foveolae and surface epithelium.

Observations upon the stomachs of asphyxiated rats show similar changes in the mitochondria of the chief cells, especially in areas evidencing injury. There are no rods, but spheres are present and apparently in reduced number. The cytoplasm of such cells is more or less vacuolated, resembling this condition in the cells of the other experimental animals. The cells of the

foveolae and the surface epithelium show no changes in the mitochondria.

The normal duodenum and pancreas. In the normal rats the mitochondria in the cells of the glands of Lieberkühn of the duodenum resemble those of the chief cells of the stomach. They are somewhat shorter, however, measuring from 2 to 4μ in length. Their distribution in the cells is likewise similar to that of the chief cells of the stomach. The epithelial cells of the villi resemble those of the foveolae and surface cells of the stomach epithelium, in so far as the mitochondria are concerned.

The mitochondria of the pancreas cells appear as long, straight rods. Their length is about twice that of those in the chief cells of the stomach. They are uniformly distributed throughout the protoplasm in the vicinity of the nucleus. The protoplasm of the cells nearest the lumen of the pancreatic alveolus contains secretory granules more frequently than it does mitochondria.

In the rats fed upon a vitamine-deficient diet the gland cells of the duodenum show spherical more frequently than rod-like mitochondria. Very often both spheres and rods occur in the same cells, but the rods are always fewer in number.

In acute inanition the mitochondria are usually absent in the cells of the glands of Lieberkühn and in the villus epithelium they are apparently decreased in number.

In the asphyxiated material there is no appreciable change in the mitochondria in the cells of either the glands or the surface epithelium of the villi.

The pancreas of the experimental animals does not exhibit abnormal areas in which the cells show evidences of injury such as occur in the stomach and duodenum. In vitamine deficiency the mitochondria are present in the gland cells, but the number of rods is decreased, most of the mitochondria being spherical in form. In the pancreas of animals suffering from acute inanition no rods occur. All of the mitochondria appear spherical in shape. Asphyxiation does not appear to modify the mitochondria in shape or number.

Because of the minuteness of the mitochondria in the pancreatic islet cells, no special study of them was attempted in these cells.

CONCLUSIONS

Vitamine deficiency and acute starvation may produce changes in the mitochondria in the gastro-intestinal epithelial cells and in the gland cells of the pancreas. Asphyxiation apparently does not produce such marked changes.

The amount of injury to the cell must be rather severe in order to bring about such changes. Cowdry ('20) reached the same conclusion from experiments upon plant rootlets.

The changes observed may involve: 1) a transformation of mitochondria from rod-like to spherical forms; 2) an apparent reduction in number of the mitochondria; 3) or even the total disappearance of mitochondria from the cells.

Because of the difficulty in obtaining uniformity of technique and the extreme variations observed in the staining reactions even in the normal cells, it is evident that great caution should be observed in drawing conclusions as to the effect of environmental changes upon mitochondria.

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Resumen por los autores, H. Cummins y J. Sicomo

Un caso de hiperdactilismo; duplicación bilateral del pulgar y primer metatarsiano de un negro adulto.

En este trabajo se describen los dos pies, ambos con seis dedos. Los dos dedos más mediales de cada pie son los pulgares. Las líneas de fricción son semejantes en los dos pulgares de cada pie. Las líneas en la planta no están modificadas. Las falanges de los pulgares y el primer metatarsiano están por completo duplicados. En los tendones del extensor y flexor largos de los pulgares existe una bifurcación, para su inserción en los dos pulgares, y en el pie izquierdo solamente, el vientre más medial del extensor corto de los dedos y el adductor están también bifurcados. En el pie derecho el abductor, adductor, y el flexor corto de los dedos se insertan salamente sobre el pulgar medial; en el izquierdo el abductor y el vientre medio del flexor corto de los dedos se insertan solamente sobre el pulgar medial, junto con una pequeña contribución del adductor, mientras que este último casi entero y todo el vientre lateral del flexor corto de los dedos están relacionados con el pulgar lateral. El curso de los vasos y nervios no presentan cambio que pudieran relacionarse germinalmente con el hiperdactilismo. Se considera a la anomalía descrita como el resultado de una variación germinal solamente en relación con la iniciación de su desarrollo. Como consecuencia de la inestabilidad germinal tuvo lugar, suponen los autores, una reproducción de los determinantes de los huesos del pulgar y de la epidermis durante la vida embrionaria temprana. Con la ulterior diferenciación de los músculos, vasos y nervios estas estructuras se adaptaron, imperfectamente en el caso de los primeros, al doble movimiento del pulgar.

Translation by José F. Nonidez
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A CASE OF HYPERDACTYLISM: BILATERAL DUPLICATION OF THE HALLUX AND FIRST METATARSAL IN AN ADULT NEGRO

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NINE FIGURES

Among the cadavers received in the anatomical laboratories of Tulane University in 1921 there was one hyperdactylous subject. The subject was a male negro, aged about fifty years, who died of chronic interstitial nephritis and chronic pleurisy. The body exhibited no external abnormalities other than the occurrence of six digits on each foot. Skiagrams identified the extra toes as halluces, and moreover demonstrated complete duplication of the first metatarsal in either foot. In spite of the large number of hyperdactylous cases reported, the opportunity for dissection of such material is relatively rare, especially in the adult. For this reason, and because of the unusual completeness of duplication in the case described, the results of its study were thought to be worthy of record. Information relating to the subject in life is not available. Therefore it is impossible to trace the inheritance of hyperdactylism in his family or to ascertain the degree of usefulness or inconvenience occasioned by the added toes.

Effective embalming of the body had been accomplished before the feet were removed. With the aim of handling them more readily in subsequent study, the feet were amputated at a level of about 5 cm. above the ankles. Although the legs were retained, to be dissected in the event that atypical muscles or other structures would require tracing upward, the occasion for dissection at higher levels did not arise. Obviously, actual prints would have been ideal material for the observation of epidermal patterns. But the hardening consequent to embalming, which

rendered every surface irregularity incompressible, and desquamation of the superficial epidermis proved to make successful prints impossible. Casting of the soles in wax was likewise unsuccessful. It was finally necessary to resort to direct study of the plantar skin and the use of drawings as records for publication. These drawings, reproduced as figures 3 and 4, are based upon careful observation of the patterns under a hand lens. Lines of interpretation were followed with ink directly upon the skin. In drawing, the interpretation lines were first inserted, their locations within the sole outline being determined by measurement; then the courses of cristae within individual areas were added in a diagrammatic manner. Wilder's paper of 1916 was used as a guide in the study of these patterns. The method of dissection requires no comment. Full notes were made as the dissection progressed, and at the same time figures 7, 8, and 9 were made in their present form, drawn by one of us and checked by the other. In studying skeletal parts use was made of the skiagrams as well as the actual bones. While other texts on descriptive anatomy were consulted, Morris' Human Anatomy was used as a guide. Lymphatics, deep veins, and ligaments were not dissected, but other structures were dissected in entirety in both feet. In many cases no mention has been made of structures which are typical, but in no case has note of a variation been omitted.

The terms *medial hallux* and *lateral hallux* are here used because each is a complete digit and of hallucal identity. In the same manner, the terms *medial first metatarsal* and *lateral first metatarsal* are applied to the bones which represent a doubled first metatarsal. *Interhallucal* is, in the restricted sense which its meaning implies, comparable to interdigital. Enumeration of the typical digits, of the metatarsals associated with them, of the interosseous spaces—in short, of all structures which are numbered in ordinary description of the normal foot—follows the terminology of descriptive anatomy.

Prof. H. H. Wilder has examined the material on epidermal patterns, including the plantar skin from both feet and our drawings and descriptions. The writers are indebted to him for

this kindness and to Dr. A. Henriques, of New Orleans, for the skiagrams.

EXTERNAL FEATURES

In their superficial appearance both medial and lateral halluces conform to the nature of fully developed digits and, further, they bear the characteristics of halluces. The medial hallux is a hallux without question, because of its large size, medial position, single phalangeal joint, and broad heavy nail. The lateral hallux is no less a great toe; in spite of its smaller size and aberrant position, it possesses the shape, single phalangeal joint, and broad nail of a hallux. In either foot the lateral hallux is in correct linear relation to the long axis of the foot. On the right foot the medial hallux is medially rotated, although its long axis is in line with the other digits. The left medial hallux is in such pronounced abduction as to project almost vertical (in a horizontal plane) to the long axis of the foot. These differences in position are to be explained below on the basis of variations in distribution of muscle insertions to the right and left medial halluces. Pronounced webs occur in all the interdigital areas of either foot and in the interhallucal area of the right foot, but not in that of the left. Owing to its supernumerary metatarsal and digit, the distal portion of each foot is wider than normal. On the medial margin, of the right foot only, there is a large prominence produced by the head of the medial first metatarsal. Owing to the hardening after embalming, any accurate determination of the contact area in life is impossible. Contact areas, judging from the hardened feet, must have been limited, restricted in size by the unusual height of the arch. Prints of the contact areas are reproduced in figures 1 and 2, which also show the general contour of the feet and positions of the digits.

Epidermal patterns are represented in figures 3 and 4. Notwithstanding slight differences in details of configuration, the hallucal patterns are alike in the two feet. The pattern consists of a single triradius and an open field, corresponding to Wilder's type BC. The first interdigital area in either foot is a loop. In the right foot the narrowed proximal portion of the loop curves

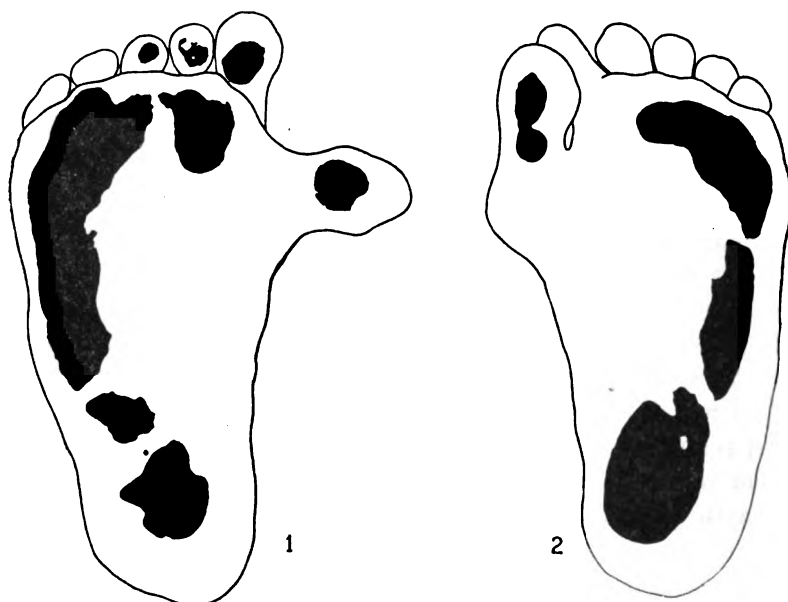


Fig. 1 Contact area of the left foot; an impression made by firmly pressing the completely inked sole of the hardened foot upon a rigid plane surface.

Fig. 2 Contact area of the right foot; made as above.

Measurements (in millimeters)

	RIGHT	LEFT
Greatest length of foot, measured from posterior extremity of heel to the furrow at bases of digits.....	211	209
Width of sole, in region of heads of metatarsals.....	115	111
Width of sole, in region of ankle.....	71	78
Greatest diameter of medial hallux.....	31	31
Diameter of medial hallux at its base.....	22	33
Length of medial hallux.....	44	45
Greatest diameter of lateral hallux.....	18	23
Length of lateral hallux.....	31	31
Maximum elevation of roof of arch, above level of contact area.....	26	28
Elevation of apex of lateral malleolus, above level of contact area.....	94	84
Elevation of apex of medial malleolus, above level of contact area.....	92	82

around the lateral border of the second interdigital area, and its ridges then become continuous with the transversely placed ridges in the depressed region of sole area at the bases of the toes. In the left foot the loop becomes confluent with the third interdigital area. In both feet the third interdigital area is an open field; in the right foot it opens at the distal margin of the

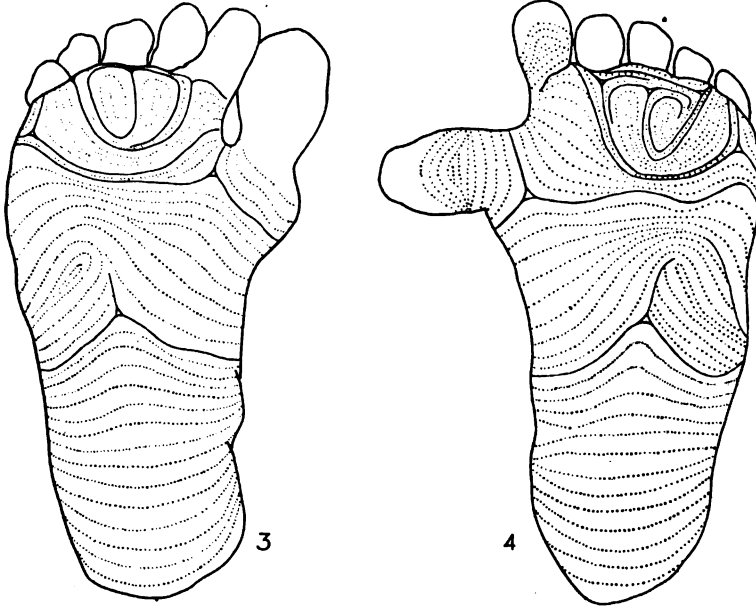


Fig. 3 Epidermal patterns of the sole, right foot; triradii and interpretation lines unbroken; courses of friction ridges shown in dotted lines.

Fig. 4 Epidermal patterns of the left foot, including digital patterns of the halluces; drawn as in the right foot.

sole area lateral to the hallucal pattern, and in the left flows into the loop of the first interdigital area. An extensive hypothenar pattern occurs on each foot, the figure being a large loop and triradius, with the opening of the loop lateral. This pattern is within the tread area. A hypothenar loop occurs in a little over half of all known sole prints. When present it usually opens medially, and often is not within the tread area. The pattern in this case thus is an unusual one with reference to its

lateral opening and its position well down on the sole. A rudimentary thenar pattern is present on each foot, indicated by the divergence of friction ridges as they course toward the medial margin of the sole. No remnant of a calcar pattern is visible. Friction ridges on the medial and lateral halluces of the one foot are counterparts of each other, and they are alike on the two feet. They are arranged in straight transverse lines at the bases of the halluces; distally they become arciform, with the convexity distal. No indications of digital triradii are to be found. Formulation of the patterns follows:

Left foot: BC. L. W. O. H.

Right foot: BC. L. + III. W. O. H.

BONES

In their morphology and number the phalanges of the medial and lateral halluces are typical in both feet. And each of the two first metatarsals of each foot is in size and morphology like the normal single first metatarsal (skiagrams, figs. 5 and 6). Distal phalanges of the right and left medial halluces are similar in size and shape, as are the distal phalanges of the lateral halluces. The proximal phalanx of the left medial hallux is larger than that of the right. On the left foot, the proximal phalanges of the two halluces, at their point of articulation with the corresponding metatarsals, diverge from each other, while on the right foot they converge. The proximal phalanx of the right medial hallux is medially rotated upon its long axis. In the left foot, the facet on the medial first metatarsal for articulation with the proximal phalanx of the medial hallux is shifted proximomedially, and in the right foot the corresponding facet is situated proximolaterally. The mutual contact surfaces of the two first metatarsals are more extensive in the left foot than in the right. In the left foot, articular surfaces and joint capsule are lacking in the region of contact, the metatarsals being held together by dense connective tissue in amount great enough to allow very little movement, if any. In the right foot, articular surfaces and joint capsule occur at this junction. Proximally, the medial first metatarsal of each foot articulates with the first

cuneiform, but the articular facet of the right one faces farther proximolaterally than does the similar facet of the left. The lateral first metatarsal of the left foot articulates proximally with the first cuneiform and with an accessory bone. This accessory bone is a triangular pyramid in shape, its base facing dorsally. It is wedged between the distal extremities of the first and second cuneiforms, articulating with them as well as with

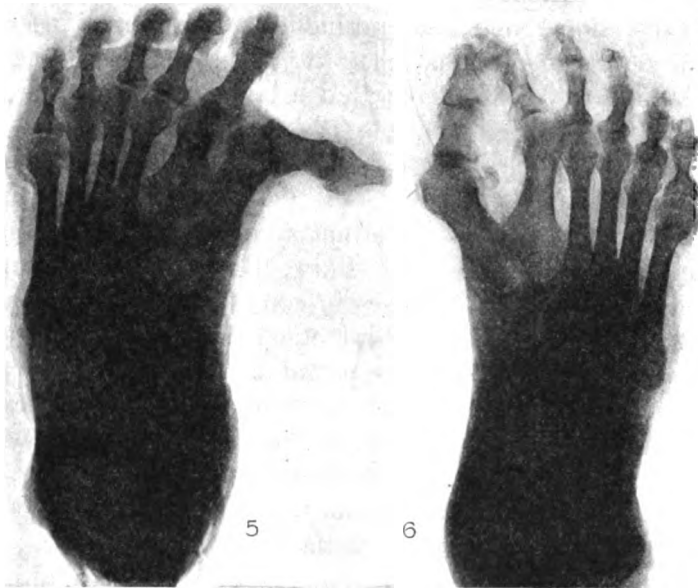


Fig. 5 Skiagram of the left foot; rayed from the dorsal aspect.

Fig. 6 Skiagram of the right foot; rayed from the dorsal aspect.

the lateral first metatarsal. The lateral first metatarsal of the right foot is extended proximally as a wedge-shaped process fitting between the distal extremities of the first and second cuneiforms. If the process were transversely separated from the body of the metatarsal, it would have the same size, shape, and articulations as the accessory bone of the left foot. From their point of articulation with the tarsus, the medial and lateral first metatarsals of the right foot diverge, and this divergence is rendered apparently greater by the constriction of their shafts. Although there is

some divergence of the same bones in the left foot, the angle is not so great and is apparently lessened through the more slight constriction of their shafts. In either foot there are sesamoids related to the heads of both first metatarsals.

MUSCLES

M. abductor hallucis in both feet is restricted in insertion to the medial hallux, with no indication of even a diffused or aponeurotic insertion upon the lateral hallux. The area of insertion, at the base of the proximal phalanx, is typical. The origin of the abductor is typical, except that a larger than usual proportion of its fibers originate from the fibrous arch on the deep surface of the muscle; the arch itself is of uncommonly great proximodistal extent.

M. flexor hallucis brevis in either foot is divided, as usual, into medial and lateral bellies. LEFT: The lateral belly is much the larger of the two. It arises in common with the adductor from the first, second, and third cuneiforms, from the latero-plantar aspect of the base of the lateral first metatarsal, and from the peroneus longus tendon, but not from the plantar calcaneocuboidal ligament. Insertion of the lateral belly is confined to the lateral hallux, at the base of its proximal phalanx. The medial belly has a dual origin, from the first cuneiform and from the fibrous arch on the deep surface of the abductor. It is readily separable into two fasciculi, medial and lateral. The origin of the lateral fasciculus is from the first cuneiform; its tendon of insertion accompanies and is fused with those of the medial fasciculus and abductor, ultimately inserting upon the medial aspect of the proximal phalanx of the medial hallux. The medial fasciculus arises only to a limited extent from the first cuneiform, most of its fibers originating in common with that portion of the abductor which comes from the fibrous arch on its deep surface. It inserts in common with the lateral fasciculus and abductor, wholly upon the medial hallux. RIGHT: The lateral belly is intimately fused with the oblique head of the adductor, and inseparable from it. Insertion, like the adductor of this foot, is confined to the medial hallux. The medial belly

is fused throughout its length with the abductor, is not separable into two fasciculi, and inserts wholly upon the medial hallux.

M. adductor hallucis in each foot is separated into the usual transverse and oblique heads, both of typical origin. **LEFT:** Tendons of insertion from the two heads are fused together and, with the tendon of the lateral belly of the flexor hallucis brevis, are inserted upon the base of the proximal phalanx of the lateral hallux. In addition, the oblique head gives rise to a small tendon which, between the bases of the proximal phalanges of the two halluces, bifurcates into a smaller medial division and a larger lateral one. The medial division inserts directly upon the plantar aspect of the proximal phalanx of the medial hallux at its base. The lateral division is continued into the longitudinal tendinous band in the tendon sheath of the flexor hallucis longus, described under that muscle. **RIGHT:** The muscle is much larger than in the left foot, especially its transverse head. Insertion is confined to the medial hallux.

M. flexor hallucis longus. **LEFT:** The tendon of insertion is bifurcated and inserts upon the bases of the distal phalanges of both halluces, as shown in figure 9. Its synovial sheath is likewise divided as it accompanies the two divisions beyond the common tendon. Proximal to the point of bifurcation, on its plantar surface only, the common tendon is superficially divided into medial and lateral halves by a slight longitudinal furrow, visible almost to the point of fusion of this tendon with that of the flexor digitorum longus. When the common tendon is forcibly split along the line of this furrow, small bundles of tendon fibers of the two components are found to interlace, but in spite of their presence the separation of the common tendon clearly follows the superficial furrow. The relation of the common tendon to the flexor digitorum longus is described under the latter muscle. In the dorsal aspect of the sheath which encloses the tendon to the lateral hallux there is a condensed longitudinal band of tendinous fibers. Proximally, most of these fibers are attached to the base of the proximal phalanx of the lateral hallux, but a few radiate medially to reach a similar attachment upon the medial hallux. Distally, this band is fused to the base

of the distal phalanx of the lateral hallux. A contribution to the band from the oblique head of the adductor has been noted above. **RIGHT:** The tendon is slightly fused with that of the flexor digitorum longus, at the point where it is crossed diagonally by the latter. Distal to the level of fusion the flexor hallucis longus tendon divides into three bundles, of which the one most medial is the largest. This medial bundle extends distally as far as the middle of the two first metatarsals, where it bifurcates into medial and lateral tendons; these insert upon the medial and lateral halluces, respectively. The tendon to the medial hallux is larger than the lateral one. The intermediate one of the three bundles, along with the above-mentioned lateral tendon of the medial bundle and with a slip from the flexor digitorum brevis, inserts upon the lateral hallux. The lateral bundle simulates a tendon of the flexor digitorum longus; it inserts upon the second digit and provides origin for the first and second lumbricals.

M. extensor hallucis longus. **LEFT:** The tendons of this muscle are represented in figure 7. Its tendon of insertion is bifurcated, and an aponeurosis is stretched between the two divisions. For the most part, the fibers of the common tendon are continued distally to insert upon the phalanges of the lateral hallux, although some fibers are contributed to the aponeurosis. The aponeurosis is attached not only to the two divisions of the extensor tendon, but also to the opposed surfaces of the proximal phalanges of both halluces and to the heads of both first metatarsals. The division to the medial hallux is aponeurotic near the common tendon, with indications of four condensed bundles of fibers which become convergent as they extend distally; insertion is at the base of the distal phalanx. The common tendon sends a long thin slip to that tendon of the extensor digitorum longus which inserts upon the second digit. **RIGHT:** In this foot the common tendon bifurcates, but the divisions are much more distinctly separate than in the left. Distally there is no aponeurosis stretched between the two divisions, and each division is a clearly separate tendon with normal insertions upon the phalanges of either hallux. Proximally, in the angle between the

two divisions, there is a slight aponeurosis which is not attached to the adjacent bones as in the left foot.

M. extensor digitorum brevis. LEFT: The most medial belly, sometimes called extensor hallucis brevis, possesses a tendon which bifurcates into medial and lateral divisions, with an aponeurosis between them. The medial division enters the aponeurosis of the extensor hallucis longus, and as a distinct fasciculus

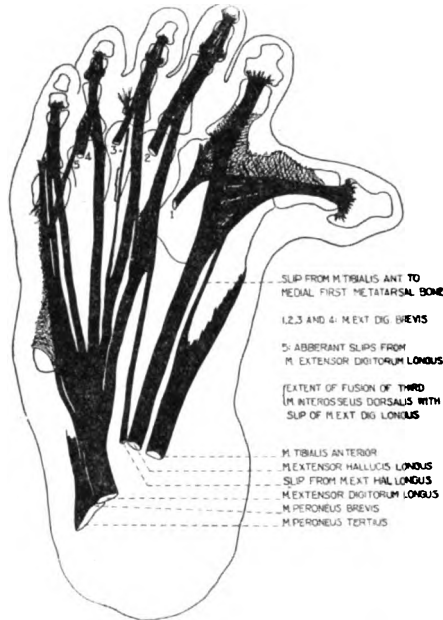


Fig. 7 Tendons of the dorsum, left foot.

is continued distally to insert upon the medial hallux at the base of its proximal phalanx. The lateral division inserts upon the head of the lateral first metatarsal and base of the proximal phalanx of the lateral hallux. The aponeurosis is continuous with that of the extensor hallucis longus, and loses its identity within the common aponeurosis thus formed. RIGHT: Here the muscle belly is typical, and inserts wholly upon the lateral hallux.

M. flexor digitorum brevis is normal in the left foot, but in the right possesses five bellies. The four lateral ones apparently represent the typical muscle, while the most medial belly inserts upon the lateral hallux.

M. flexor digitorum longus. LEFT: This muscle sends a slip from its tendon to that of the flexor hallucis longus, the level of origin of the slip being slightly proximal to the insertion of the quadratus plantae (superficial portion of the medial head) into the tendon of the flexor digitorum longus. The position and direction of fibers in the slip indicate that they are destined to reach the medial hallux only. There are two distinct strata in the tendon, superficial and deep. The deep stratum is composed of fibers issuing from the tendon of the flexor hallucis longus, at about the same level as the slip to this tendon, and continuing distally as two tendons inserting upon the second and third digits. Tendons to the fourth and fifth digits are from the superficial stratum, the one to the fifth digit being small and rudimentary. RIGHT: Coincident with the replacement of its most medial tendon by a slip from the flexor hallucis longus, this muscle has only three tendons of insertion. The most medial of the three sends a slip into the lateral bundle of the flexor hallucis longus. Also small bundles of fibers pierce directly through the tendon of the flexor hallucis longus, and are continued distally as longitudinal fasciculi to reenter the tendon to the third digit. The most lateral of the three tendons is unusually large; it receives a slip from the flexor digitorum brevis.

M. quadratus plantae in either foot is divided into the usual medial and lateral heads. LEFT: The medial head is separated into two strata, superficial and deep. Insertion of the former stratum is upon the lateral margin of the plantar surface of the flexor digitorum longus tendon, superficial portion. The deep stratum inserts upon the lateral margin of the deep portion of the same tendon. The lateral head inserts like the deep stratum of the medial head, but more distal. RIGHT: Insertion of the medial head is upon the tendon of the flexor digitorum longus, on its lateral margin and dorsal aspect just proximal to the trifurcation of the tendon. The lateral head inserts upon the

lateral margin of the lateral bundle of the flexor hallucis longus and upon the three tendons of the flexor digitorum longus.

M. peroneus longus in either foot is typical, but that portion which normally inserts upon the first metatarsal is here limited to the medial first metatarsal.

M. interossei do not occur between the two first metatarsals of either foot.

SUPERFICIAL VEINS; ARTERIES

The courses of superficial veins are alike in the two feet, with no deviations of note other than provision for drainage of both halluces. These vessels of the dorsum of the left foot are shown in figure 8.

A. dorsalis pedis. LEFT: The first dorsal metatarsal (*a. dorsalis hallucis*) arises in line with the navicular, so far proximal as to carry the medial tarsal branch with it. Its primary distribution is normal. A branch to the deep structures in the interosseous space between the two first metatarsals arises from it, in line with the bases of the first metatarsals. It gives no supply to the medial hallux. RIGHT: General relations of *a. dorsalis pedis* are as in the left foot, but the second dorsal metatarsal does not originate from the dorsal arch. Instead, it comes from the plantar arch, issuing through the proximal extremity of the second interosseous space, to be distributed in the manner of a second dorsal metatarsal.

A. plantaris lateralis and ramus plantaris profunda. LEFT: The former vessel is of uncommonly small diameter. From it the following branches originate, in order beginning laterally: 1) A branch which courses distally on the plantar surface, bifurcating, in line with the head of the fifth metatarsal, into medial and lateral terminals. The lateral supplies the lateral aspect of the fifth digit and the adjacent plantar surface and lateral margin of the foot. The medial terminal supplies the opposed surfaces of the fourth and fifth digits. 2) A metatarsal supplying the opposed surfaces of the third and fourth digits. 3) A branch supplying the deep structures adjacent to the distal portions of the first and second interosseous spaces. 4) The

continuation of the arch medial to the last-named branch is an extremely small artery, which, on the lateroplantar aspect of the base of the lateral first metatarsal, joins the deep plantar branch of the dorsalis pedis. From the medial aspect of this junction there is an artery, which, because of its large size and linear relation to the deep plantar, is considered to be a continuation of the deep plantar rather than of the plantar arch. This artery continues medially as far as the line of contact between the two first metatarsals, where it turns distally in the interosseous space between them and is joined by the 'deep branch proper' of the medial plantar. The common trunk distal to the junction, larger in diameter than would be expected of a metatarsal, is distributed to the interhallucal area and opposed surfaces of the two halluces. RIGHT: As in the left foot, the contribution of the lateral plantar artery to the plantar arch is reduced not only with reference to the diameter of the vessel, but also as to the distance which it extends medially and the number of branches originating from it. There are three branches of the lateral plantar; they are, in order beginning laterally: 1) A branch to the lateral aspect of the fifth digit and the adjacent plantar and lateral region of the foot. 2) A branch which perforates the proximal extremity of the first interosseous space and is distributed as a dorsal metatarsal (noted under a. dorsalis pedis). 3) The lateral plantar artery terminates by anastomosing with the lateral trunk of the deep plantar. The deep plantar issues through the proximal end of the first interosseous space, dividing immediately into two large trunks, lateral and medial. The lateral trunk gives rise to two branches, lateral and medial, at the point of junction of this trunk with the lateral plantar. The lateral branch almost at once divides into two plantar metatarsals, coursing, respectively, in the fourth and third interspaces. The medial branch is distributed as a plantar metatarsal to the second interspace. Distally, the most medial two of the three plantar metatarsal branches receive anastomoses from the superficial branch of the medial plantar. The medial trunk crosses the base of the lateral first metatarsal, and then turns distally in the interosseous space between the two first metatar-

sals; at the middle of this space it divides into two branches, plantar and dorsal. The plantar branch anastomoses with the deep branch of the medial plantar; beyond the anastomosis it runs superficial to the insertion of the adductor hallucis, and then anastomoses with the dorsal branch. Two digital branches, distributed to the opposed surfaces of the halluces, arise from the plantar branch. The dorsal branch turns dorsally in the inter-hallucal area, first giving rise to a branch reaching the base of the medial hallux, then arching toward the plantar surface, where it enters into anastomosis with the plantar branch. In its course toward the plantar surface it gives origin to a digital branch to the medial side of the lateral hallux. It is evident that the anastomosis between the dorsal and plantar branches of the deep plantar results in the formation of an arterial ring which also receives a contribution from the deep branch of the medial plantar. Both heads of the adductor and the lateral belly of the flexor hallucis brevis are encircled by the ring, near their insertions upon the medial hallux.

A plantaris medialis. LEFT: From the superficial branch there are two branches of especial interest in that they replace two of the metatarsal arteries typically originating from the plantar arch. These two arteries supply, respectively, the opposed surfaces of the second and third digits and the opposed surfaces of the lateral hallux and second digit. The deep branch, in line with the middle of the medial first metatarsal, divides into a deep branch proper and a medial digital branch. The latter supplies the medial and plantar aspects of the medial hallux. The deep branch proper continues distally, ultimately joining the deep plantar artery. RIGHT: From the superficial branch there are three small branches anastomosing with the most medial three plantar metatarsals. The deep branch supplies a digital branch to the medial hallux.

NERVES (figs. 8 and 9)

The *sural* in either foot is a little larger in diameter than usual. It descends on the lateral border of the tendon Achilles, posterior to the lateral malleolus, and before turning distally

it gives a large branch which fans out on the lateral surface of the heel; this branch takes the place of the usual lateral calcaneal branches. Distal to this branch the sural is continued along the lateral border of the foot as the lateral dorsal cutaneous nerve, supplying many small branches to the region through which it courses. Ultimately the nerve divides into two dorsal digital branches, one for the lateral surface of the fifth digit and one for its dorsum.

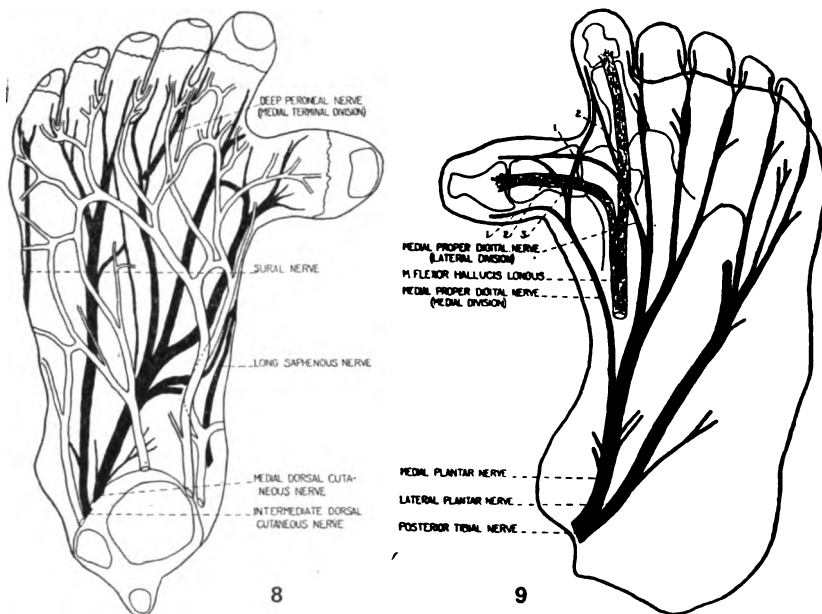


Fig. 8 Superficial veins and nerves of the dorsum, left foot; veins in open lines and nerves solid.

Fig. 9 Plantar nerves and tendon of the flexor hallucis longus, left foot.

The *intermediate dorsal cutaneous* is alike in both feet, with one exception. The nerve divides distally into three dorsal digital branches: the first, from lateral to medial, innervates the adjacent sides of the fourth and fifth digits; the second, the adjacent sides of the third and fourth digits, and the third, the medial side of the third digit. Slightly proximal to the point of origin of these branches, the common trunk gives rise to a prominent

branch which anastomoses with a branch of the medial dorsal cutaneous, and this combined nerve anastomoses distally with the third dorsal digital branch of the intermediate dorsal cutaneous. These anastomoses are lacking in the right foot.

The *medial dorsal cutaneous* divides into five branches in the left foot, only four in the right, the branch lacking in the right foot being the one entering into the anastomosis mentioned above. Beginning laterally, the first branch supplies the lateral surface of the second digit; the second and third branches anastomose distally and innervate the medial surface of the lateral hallux, the interhallucal area and the lateral, dorsal and medial surfaces of the medial hallux; the fourth branch anastomoses with a direct continuation of the long saphenous, and both innervate the medial aspect of the foot.

The *deep peroneal, medial terminal division*, in either foot, retains its normal position with reference to the second digit, between it and the lateral hallux, with no branches extending to the medial hallux.

The *medial plantar* in either foot possesses two branches which are comparable to the typical single medial proper digital branch; these are for convenience designated the medial and lateral divisions of that branch. The medial division divides into three digital branches which supply the medial and lateral surfaces of the medial hallux and the medial surface of the lateral hallux. The lateral division terminates in two branches, the first of which anastomoses with the second one of the medial division to supply the lateral surface of the medial hallux. The second branch anastomoses with the third one of the medial division and supplies the medial surface of the lateral hallux.

DISCUSSION

Annandale classifies supernumerary digits in four groups: 1) deficient, loosely attached by a narrow stalk to the hand or foot or to another digit; 2) more completely developed, free distally and articulating with the head or sides of a metacarpal, metatarsal, or phalanx; 3) completely developed and separate, and, 4) intimately united, longitudinally, with another digit, and either

provided with a metacarpal or metatarsal of its own or articulating with the head of one common to it and another digit. The case described is to be referred to class 3, since each hallux is separate and completely developed, even to the extent of possessing a metatarsal of its own. That the two most medial digits of either foot are halluces is demonstrated particularly by their external features, bones, and muscles.

Concerning the factors underlying the production of extra digits, at least three explanations have been advanced. An older view accounts for the anomaly on the basis of reversion. But, as is indicated by the facts briefly outlined in the following extract from Prentiss ('06), the theory is untenable in accounting for hyperdactylism in man or other pentadactylous mammals.

We may assume that the primitive and typical mammalian foot was pentadactyl, in spite of Bardeleben's contention that the progenitors of the mammalia possessed not five, but seven digits. Bardeleben's assumption was based upon the observation that certain mammals, the whale, for example, have more than five digits; that among five-toed forms six and seven digits occasionally occur; and that in many species small cartilages are present on each side of the hand and foot. These cartilages Bardeleben regards as digital rudiments, and the occurrence of extra digits is explained by him as reversion, a 'turning back' through heredity, to ancestral conditions. Unfortunately, the facts do not support this beautiful theory. Paleontology tells us that the forerunners of the mammalia possessed only five toes. Embryology has shown that the sixth digit of the whale, and the cartilages which Bardeleben supposes to be digital rudiments, develop secondarily some time after the typical five digits have appeared. Finally, observations have proved that the extra digits which occur in polydactylism do not develop from Bardeleben's 'digital rudiments,' but originate in an entirely different manner. We may, therefore, assume that the primitive mammalian foot was pentadactyl, and this being so, the occurrence of six or seven digits on a foot normally five-toed can not be attributed to reversion, unless we assume with Albrecht that it is reversion to the many-rayed fins of the Elasmobranch fishes, an absurd supposition.

The second causal factor postulated is that of mechanical influences which distort the embryonic hand or foot. It is not unlikely that some cases of imperfectly developed supernumerary digits, especially if unilateral, might be the result of compression or constriction by amniotic bands. In fact, Ahlfeld (cited by Prentiss) "has observed that digital duplications may

be caused 'in utero' by pressure from the thread-like growths of the amnion." The very existence of a family history of hyperdactylism, present in most cases, would argue against the operation of such a factor, as would the usual bilateral occurrence (Broman) of the duplication and the much more frequent involvement of the first and fifth digits rather than the intervening ones (Prentiss). Still more conclusive argument against a general postulation of mechanical factors is furnished in the existence of hyperdactylous identical twins. Stockard presents a case of identical twins in which both twins possess apparently the same type and degree of hyperdactylism—six digits on each hand and foot. In the same connection, Danforth describes the left hands of a pair of twins, possibly identical, each having a supernumerary fifth digit which is small and imperfectly developed.

We are led, then, to the probably almost invariable source of hyperdactylism, namely, an intrinsic factor or complex of factors, non-atavistic in nature. The arguments set forth above as opposed to mechanical induction favor not only the assumption of intrinsic factors, but also possibly an almost universal operation of potentialities transmitted by the germplasm. However, hyperdactylism occurs in monsters (Gräfenberg) as well as in individuals who are otherwise normal, the genesis of such monsters being explained by Stockard on the basis of developmental arrest. In these cases it seems not unreasonable to assume that causative factors which are non-germinal, but which operate intrinsically in modifying the normal rate of development, may bring about the condition of hyperdactylism coexistent with deformities which are unquestionably non-germinal in origin.

Prentiss repeatedly states that the germinal factor is not productive of invariable particular duplications, but rather is only a tendency toward duplication, exhibiting itself in successive generations as variable types and degrees of hyperdactylism or even merely as increased size of the first or fifth digits. Both Broman and T. Lewis note the frequent association of hyperdactylism and syndactylism in the same individual; Prentiss ('10) describes a case of hyperdactylism associated with deficiency

of the frontonasal process, and a legion of cases of heritable developmental defects coexistent with hyperdactylism occur in the literature. Then is it not warrantable to conclude that hyperdactylism of germinal origin is the immediate result of an instability in the autonomous control of developmental processes, the heritable factor being the instability and not the particular duplication? There seems to be a parallelism in the results of this instability and defects induced by experimental modification of developmental rate. Stockard concludes that various types of experimentally produced defects may be obtained by identical treatment of the embryos, and, further, that the type of defect is dependent upon the time at which developmental arrest is induced by the treatment. If such a parallelism does exist, the type and degree of hyperdactylism may be dependent upon the period at which germinal instability comes into play. On the other hand, if there is no correspondence in the action of experimental arrest and germinal instability, the degree of instability may, conceivably, be measured by the type and degree of duplication. In either case, it is apparent that a certain amount of selectivity exists, in that the first and fifth digits are most frequently affected. Prentiss points out that these digits are in the process of modification and regression, respectively; he suggests that these digits are thus more unstable, more plastic, and hence would be the most common sites of variation.

Hyperdactylism in the case described is assumed to have been produced by germinal factors. It is not believed that there was provision in the parental germ cells for both halluces in toto, or, if the foregoing arguments hold, even for the particular duplication. Rather, the immediate cause is presumed to have been an instability, transmitted germinally, perhaps in the form of a modification in rate of development which occurred in very early embryonic development. From the anatomical findings it is concluded that this instability resulted in a complete duplication of the germinal determinants for hallucal epidermis, hallucal phalanges, and first metatarsal. Further, it is concluded that the same instability need not have directly influenced muscles, vessels, and nerves, that the adaptation of these structures

to the doubled hallucal environment could have been secondarily induced.

Conclusions drawn from observations on individual systems are summarized in the following paragraphs.

Friction ridge patterns of the sole show no variations concerned with the hyperdactylous condition. By virtue of its position, the medial hallux has appropriated the hallucal pattern. The pattern itself shows no cleavage, duplication or even attempted duplication. In the absence of any disturbance within the hallucal pattern, it seems that there must have been no germinal provision for accessory hallucal patterns correlated with the duplication. In embryonic development the physical separation of the hallucal epidermal area into two isolated digital areas must have been preceded or accompanied by readaptation of the epidermal determinants. Determinants for general skin of the hallux, its nail and digital friction ridge patterns must have completely reproduced themselves. Their reproduction could have been incited through the primary action of the developmental instability (arrest?), or secondarily through doubling of the hallucal environment, but unlikely by a direct germinal provision for two hallucal digital epidermal areas, the unmodified hallucal pattern being contraindicative.

Doubled sets of bones, structurally like those of the normal hallux and its metatarsal, must be, developmentally, the result of a qualitatively complete duplication of the determinants for bones of the single hallux and first metatarsal. The time at which such duplication occurred and even the sequence of ontogenetic events following it are a matter only of conjecture. Potentially, two sets of bones may have been present long before they were evident structurally, the reproduction of determinants for bones having been an early and direct effect of the developmental instability. Once formed, the hallucal phalanges and first metatarsals seem to have served as cores or points of reference about which other hallucal structures were developed. Bardeen ('10) describes the normal development of the foot bones. Their first appearance is in the form of a foot plate, a condensation of the formerly more diffuse mesenchyme in the

distal portion of the posterior limb bud appearing during the fifth week. Toward the end of the fifth week, five localized areas of still greater condensation appear within it, the digital rays. During the sixth and seventh weeks, each digital ray segments transversely into, first, a metatarsal, and then the phalanges of a digit. Coincidentally, anlagen of the separate tarsal bones appear within the proximal portion of the foot plate, becoming more distinctly outlined toward the end of the second month. In our case the complete development of individual bones would point to an extremely early appearance of the supernumerary toes. Perhaps when first condensed within the foot mesenchyme the foot plate may have been wider than normal, its most medial region bearing tissue for the development of two metatarsals instead of one and two sets of hallucal phalanges. With the condensation of digital rays, six instead of five may have been formed, each of the two most medial carrying the germinal nature of the typical most medial one. Or, perhaps five digital rays appeared within the foot plate, and the most medial one was cleft longitudinally into two. It seems unlikely that a cleavage much later than this could be accountable for the well-developed bones met with in both feet. The duplication apparently does not invade the region of the tarsus. However, the accessory bone of the left foot may be the result of an abortive duplication of the first or second cuneiform, which in the right foot was secondarily ankylosed with the lateral first metatarsal. More likely, the accessory bone represents the epiphysis of the lateral first metatarsal, isolated in the left foot and normally fused with the shaft in the right.

The absence of a germinal provision for muscles is inferred from the absence of interossei between the two first metatarsals, the failure to produce any new muscles and the lack of adaptation of some muscles to both halluces. As a consequence of the last two deficiencies, the halluces of either foot are provided with an unequally distributed musculature. In the right foot the abductor, adductor, and both bellies of the flexor hallucis brevis insert wholly upon the medial hallux. The same muscles are more evenly allotted to the two halluces of the left foot, where the

abductor, medial belly of the flexor hallucis brevis, and only a very minor portion of the adductor insert upon the medial hallux, leaving the major portion of the adductor and the entire lateral belly of the flexor hallucis brevis for the lateral hallux. The tendons of the long hallucal flexor and extensor are bifurcated and insert upon both halluces of either foot. The distribution of muscles is regarded as secondary, the variations described being induced through the relations of the developing muscles to the already doubled osseous environment. From Lewis' account of the embryology of the foot muscles ('10), it appears that isolation of individual muscles from the premuscle masses may be either coincident with or subsequent to the appearance of anlagen for the separate bony elements with which they later become related; but the selection of their definitive insertions naturally follows the differentiation of the bones upon which they insert. The developing bones may be considered as points of reference which govern attachments of muscles, their influence being specific for particular bones and for localized regions upon any one bone. Whether the influence is determined through germinal inheritance or is the result of the recognized interdependence of structures in development, or both, a definite dynamic nature may be attributed to the developing bones. Muscle attachments in the feet described are believed to be the result of operation of such dynamic factors, variations concerned with hyperdactylism being secondarily produced through doubling of the bones. Assuming that each of the two halluces carries a full complement of the dynamic factors governing insertions of individual hallucal muscles upon particular areas of their bones, as is indicated by normal areas of attachment and typical morphology of the bones themselves, it is inferred that each hallux can control attachments of those muscles which are environmentally related to it, rather than to the other hallux. That the two halluces of each foot exerted approximately equal control of those muscles related to their dorsal and plantar surfaces is evidenced by bifurcation of the long extensor and flexor tendons. On the right side, the insertion upon the lateral hallux of a slip from the flexor digitorum brevis suggests the environmental

displacement of this hallux. This accessory slip and a similar one to the medial hallux from the flexor digitorum longus perhaps are the consequence of the unnatural expansion of their flattened embryonic tendon plates, due to increased width of the foot as a whole, with subsequent formation of supernumerary tendons. In the right foot the medial hallux more nearly assumes the nature of a normal hallux, with regard to musculature, and thus is assumed to have been in an environment approaching the normal. Of the four halluces concerned, the lateral hallux of this foot appears to be farthest removed from a hallucal environment while in the left foot the two halluces seem to be complementary with reference to the medial and lateral aspects of the normal hallux.

Since arterial variations occur, not in the courses of main trunks, but in the size, number, and distribution of terminal branches, it is inferred that they are the result of environmental relationships in development rather than of any germinal correlation between hyperdactylism and the differentiation of vessels. Senior describes the formation of dorsal and plantar plexuses within the mesenchyme of the foot, from which are derived all the arteries on the dorsum of the foot, the plantar arch and all the terminal branches on the distal portion of the sole (excepting the trunks of the lateral and medial plantar arteries). The three trunks, medial plantar, dorsalis pedis (resolved within the dorsal plexus), and lateral plantar, establish their permanent connections in the order named. While no emphasis is placed upon the ascendancy of the deep plantar and medial plantar in supplying the region of duplication, the fact is at least suggestive of a permanent dominance of those vessels which first establish their permanent connections in a region characterized by an abnormally large mass of tissue.

There is no involvement in the courses and fundamental relations of the nerve trunks. Thus the medial terminal division of the deep peroneal retains its typical relation and is not influenced by the medial hallux. This relation recalls the insertions of hallucal muscles as they obtain in the left foot. Branching of the medial dorsal cutaneous and medial plantar nerves is

suggestive of the bifurcated extensor and flexor tendons to the two halluces. The complex interrelation between the medial and lateral divisions of the medial proper digital may be the result of retained regionally specific dynamic influences of the normal single hallux. The combined cross-section areas of the two hallucal branches of the medial dorsal cutaneous are approximately twice that of the normal single branch; this relation holds also for the two branches of the medial plantar which supply the halluces. Unfortunately, no counts of the contained nerve fibers could be made, to determine whether the increased volume is due to excess in number of nerve fibers or amount of connective tissue. Even though a correlation between number of spinal ganglion cell bodies and increased area to be supplied does exist, it seems hardly necessary that germinal factors provided the mechanism for correlation. Occurring early, the duplication of the hallucal sensory area might still influence the proliferation of ganglion cells.

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Resumen por el autor, Albert Kuntz.

Un caso de preñez anormal con retención de los fetos muertos en el conejo.

Una coneja preñada exhibía en la cavidad peritoneal dos fetos muertos encapsulados a término y en el útero dos fetos normales vivos de 18 mm. de longitud. Los tejidos de los fetos muertos aparecían necróticos pero bien conservados. Las membranas coriónica y amniótica faltaban, excepto en el área placentaria. Las cápsulas consistían en membranas delgadas de tejido conectivo viable con abundante irrigación sanguínea, si bien su inserción en cualquiera de las estructuras intraabdominales era muy ligera.

Translation by José F. Nonides
Cornell Medical College, New York

A CASE OF ABDOMINAL PREGNANCY WITH RETENTION OF DEAD FETUSES IN THE RABBIT

ALBERT KUNTZ

St. Louis University School of Medicine

ONE FIGURE

In the routine of laboratory work a female rabbit was found which, when the abdominal cavity was laid open, exhibited two encapsulated dead fetuses in the peritoneal cavity and a pregnant uterus containing two normal living fetuses 18 mm. in length. I am indebted to Dr. M. S. Fleisher for this material.

The literature of obstetrics and gynecology contains the reports of not a few cases of abdominal pregnancy in the human species. In some of these cases a dead fetus was carried in the peritoneal cavity for a relatively long time following the normal period of gestation. Barring infection or accident in such cases, the fetal tissue slowly undergoes absorption. A few cases of abdominal pregnancy in animals have also been reported.

In the majority of the reported cases of abdominal pregnancy the fetal envelope and placenta, in cases examined early, or the capsule containing the dead fetus, in cases examined late, showed extensive and firm attachment to the peritoneum or mesentery. Not uncommonly, one of the ovaries was involved in the attachment. When the present case came into my hands the encapsulated fetuses were lying unattached in the peritoneal cavity. The laboratory assistants who had opened the abdominal cavity and removed the fetuses insisted that they had broken no attachments of the capsules to any intra-abdominal structure. Furthermore, careful inspection of the capsules revealed no areas of attachment.

The encapsulated dead fetuses, the ovaries, the uterus, and the living fetuses contained in it were fixed and preserved in 10 per

cent formalin and subjected to further study. The ovaries proved to be normal in all respects, containing both corpora lutea and corpora albicantia. The fallopian tubes also were normal. The presence of normal living fetuses in the uterus is of little importance except as an indication that the encapsulated fetuses were carried as dead bodies in the abdominal cavity for some time. There is no means at hand of determining how much time elapsed between the successive pregnancies. Encapsulated with each dead fetus was a mass of dead placental tissue. The capsule was closely applied to the fetus and the placental mass and presented the appearance of a thin connective tissue membrane. One of the encapsulated fetuses is illustrated photographically in the accompanying figure (fig. 1).

Upon microscopic examination the fetal tissues were found to be necrotic, but still sufficiently well preserved to admit of reasonably good staining. The skin was intact and well covered with hair. Sections through the capsule and the underlying skin revealed only remnants of amnionic or chorionic tissue. Obviously, these tissues were almost completely absorbed except in the placental area. The capsule consists of a thin connective-tissue membrane containing numerous small blood vessels. It does not blend with the placental mass, but is continuous over the surface of the latter and is of the same character in this area as in areas in which it lies in contact with the fetal integument. The capsular tissue was perfectly fixed and reacted to the stain like freshly killed connective tissue. It does not present the histological appearance of the mesodermal portions of the fetal membranes, but rather that of viable connective tissue. Therefore, the capsule is not of embryonic but of maternal origin. Inasmuch as the capsule consisted of living connective tissue with an abundant vascular supply, we must conclude that it was attached to the peritoneum or mesentery at some point, although the attachment was so slight that neither was it observed during the postmortem examination, nor was the area involved detected on later inspection of the capsule.

As indicated above, the ovaries and fallopian tubes were normal in all respects. No scars or other evidence of tubal or ovarian

pregnancy which might have ruptured or discharged into the peritoneal cavity could be detected. The possibility of primary abdominal pregnancy cannot be precluded. However, the absence of evidence of some other type of ectopic pregnancy in this case does not warrant the conclusion that the ova were extruded into the peritoneal cavity before they had secured implantation sites elsewhere. According to the modern view as



Fig. 1 Photographic illustration of encapsulated dead fetus

set forth by Kelly,¹ Williams,² and others, the theoretical possibility of primary abdominal pregnancy is admitted, but conclusive evidence that it actually occurs is not forthcoming. Conclusive proof of primary abdominal pregnancy in any case in which gestation is well advanced is obviously impossible. The facts in the present case are not incompatible with the theory that the ova were discharged into the peritoneal cavity after gestation was initiated.

¹ Kelly. Amer. Textbook of Obstetrics. 1895.

² Williams. Obstetrics. 1912.

BOOKS RECEIVED

(Continued from first page)

AN INTRODUCTION TO ZOOLOGY by C. H. O'Donohue, D.Sc., F.Z.S., Professor of Zoology, University of Manitoba, 502 pages, illustrated. New York: D. Appleton and Company, 1921. "The object of this volume is to provide a text-book for the zoological position of the syllabus in Biology for the First Examination for Medical Degrees of the University of London, and the First Examination for the Conjoint Examining Board in England of the Royal College of Physicians of London and the Royal College of Surgeons of England. It is hoped that it will also prove useful to students preparing for similar examinations, and for those who are taking classes, like the pre-medical courses in American Universities, requiring a knowledge more particularly of Vertebrate Zoology." *From the Preface.*

THE ANATOMY OF THE NERVOUS SYSTEM from the standpoint of development and function, by Stephen W. Ranson, M.D., Ph.D., Professor of Anatomy in Northwestern University Medical School, Chicago. Octavo volume, 395 pages, 260 illustrations, some of them in colors. Philadelphia and London: W. B. Saunders Company, 1920. \$6.50 net. "The anatomy of the nervous system has been presented from the dynamic rather than the static point of view. Structural details become interesting when their functional significance is made known. During the past twenty years very considerable additions have been made to the science of neurology, and the more important of these have been included in the text."

SURGICAL ANATOMY, by William Francis Campbell, M.D., Surgeon-in-Chief at Trinity Hospital, Brooklyn, N. Y.; sometime professor of Anatomy and Professor of Surgery Island College Hospital. Third Edition, Revised. 681 pages, 325 illustrations. Philadelphia and London: W. B. Saunders Company, 1921. Cloth \$6.00 net. "The student's interest in anatomy is vitalized only as the anatomic facts are correlated with those practical problems with which he is confronted as a practitioner of medicine."

SIMPLE METHODS OF CORRELATING CROWN-RUMP AND CROWN-HEEL LENGTHS OF THE HUMAN FETUS¹

G. J. NOBACK

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ONE FIGURE

Investigators in prenatal anatomy and development report their findings in one of three ways as regards length of the individuals studied. Some writers use both crown-rump and crown-heel length (Michaelis, '06; Mall, '10). Others use only the crown-rump (Streeter, '20), and some use the crown-heel alone (Meyer, '15; Scammon, '19; Noback, '21). Work based on one of these measurements alone is obviously difficult to compare with work based upon the other.

The relation between the crown-rump and the crown-heel lengths during fetal life is practically constant. The formulae here presented further demonstrate this fact.

The crown-heel length of the human fetus is equal to the crown-rump length (in millimeters) minus one, plus one-half of this amount. The following formula makes possible the utilization of data reported in crown-rump length which is to be compared or combined with data based upon the crown-heel length alone.

$$CH = \frac{3CR - 3}{2}$$

Illustration: The known crown-rump length is 95 mm. What is the corresponding crown-heel length?

$$CH = \frac{3 \times 95 - 3}{2}$$

i.e., the crown-heel length is 141 mm.

¹The formulae in this report were demonstrated at the thirty-seventh session of the American Association of Anatomists, March, 1921.

The second formula may be used to determine the crown-rump length when the crown-heel length is known. It is expressed as follows:

$$CR = \frac{2CH + 3}{3}$$

Illustration: The known crown-heel length is 141 mm. What is the corresponding crown-rump length?

$$CR = \frac{2 \times 141 + 3}{3}$$

i.e., the crown-rump length is 95 mm.

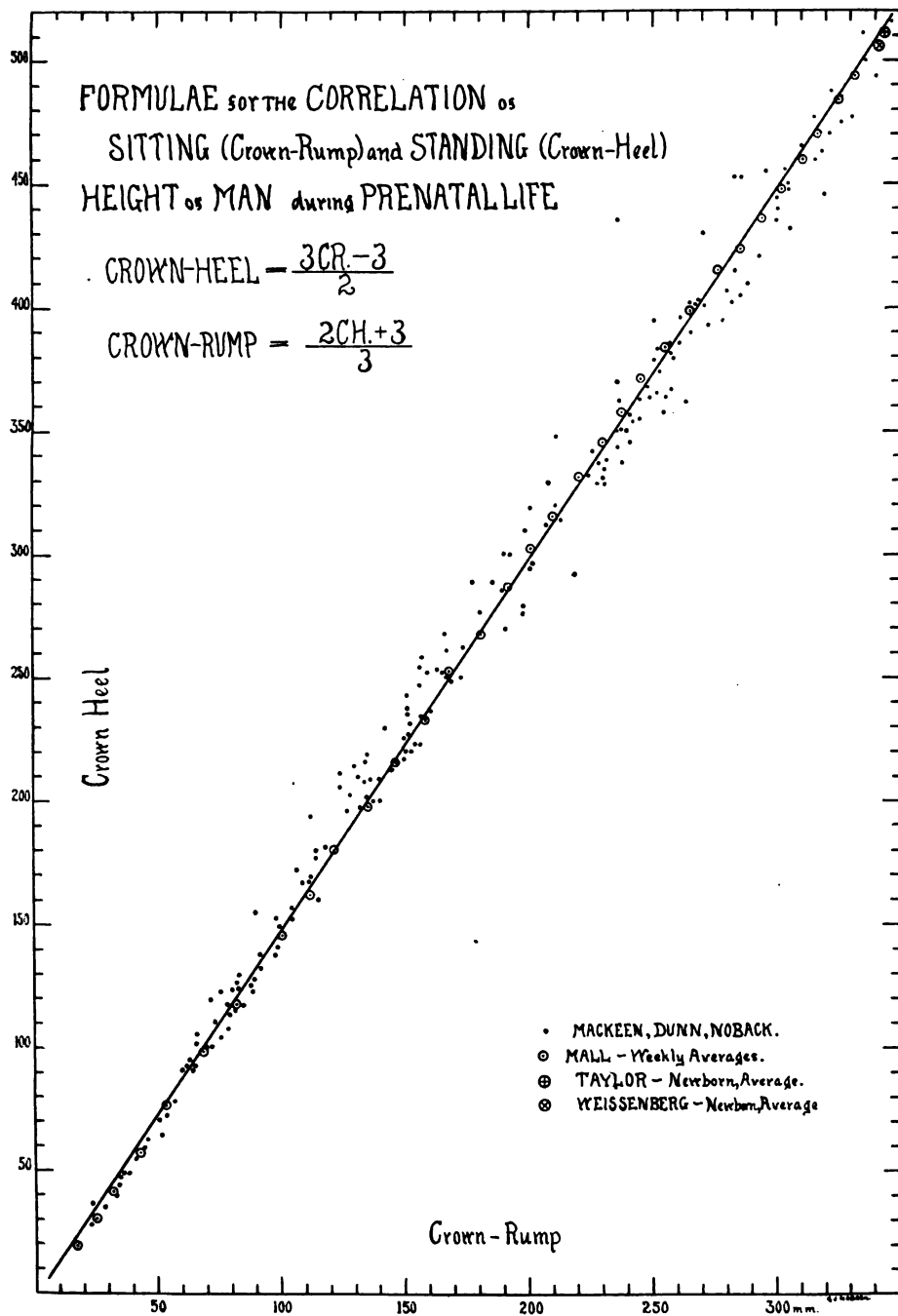
In order to determine to what extent measurements made by different observers would deviate from the formulae, I have plotted them on ordinate paper against the curve obtained by use of the formulae. The crown-rump lengths are represented by the abscissas and the crown-heel lengths by the ordinates. The accompanying plate shows the formulae curve as a straight line, and it is readily seen that the measurements made by the several observers are distributed quite evenly about it.²

The following table shows the extent of deviation from the lengths derived by formula in the data of Mall, MacKeen, and Michaelis.

	AVERAGE DEVIATION	PERCENT- AGE DEVIATION
Mall (weekly averages of 1000 cases).....	2.4	0.7
MacKeen (161 cases).....	9.5	3.6
Michaelis (weekly averages from 14 weeks to birth).....	11.5	3.3

Two sets of data on measurements of the newborn infant are also plotted against the curve. These observations were made by Taylor '19 and by Weissenberg '06. The averages of their measurements vary but a trifle from the curve derived by the formulae.

² Besides data of Mall and of Michaelis I have used measurements made in the Institute of Anatomy, University of Minnesota, by Helen Adams MacKeen and by Halbert Dunn. The work of the latter two investigators will appear in due course.



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Resumen por el autor, Leslie B. Arey.

Prueba directa del origen monozigótico de los gemelos humanos idénticos.

Los gemelos humanos idénticos o mellizos homólogos se originan a expensas de un solo óvulo, conforme demuestra el autor por primera vez en el presente trabajo. El saco vitelino humano es un vestigio innecesario para el crecimiento o la diferenciación (incluso la vasculogénesis). La doctrina del origen local de la vasculogénesis está soportada por los hechos, dentro de los límites de la posibilidad experimental, en los mamíferos.

Translation by José F. Nonides
Cornell Medical College, New York

DIRECT PROOF OF THE MONOZYGOTIC ORIGIN OF HUMAN IDENTICAL TWINS¹

LESLIE B. AREY

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ONE PLATE (SIX FIGURES)

The commonest seat of ectopic pregnancy is the uterine tube. When such tubal gestations are plural, they may be either unilateral or bilateral in position. The former type, that is, the presence of more than one fetus in the same tube, is somewhat the rarer; a careful examination of the literature ('22 a) has yielded thirty-eight positive or authentic cases, eight probable or presumptive cases, and four possible but doubtful cases. To the positive list I have there added two new cases of monochorial twins, each unique of its kind. Detailed descriptions of these specimens, summaries of all the other cases, together with the general conclusions drawn from an analysis of the anatomical and clinical data afforded, may be found elsewhere ('22 a, '22 b, '22 c). This note is confined to the presentation of certain features of peculiar embryological interest and significance.

The first of the two new specimens,² consisted of a single chorionic sac which contained twin embryos, each 12.3 mm. long (fig. 1). There is a common yolk sac from which distinct yolk stalks arise near together and pass to their respective umbilical cords. The cut stumps of these yolk stalks and their separate origin from the sac are clearly shown in figures 2 and 3.

¹ Contribution no. 90.

² This twin specimen belongs in the collection of the Carnegie Institution, where it is listed as no. 1128. Acknowledgment is due the director, Dr. George L. Streeter, for permission to describe it. He has also furnished the accompanying photographs (figs. 1 to 3).

There has been no real doubt that human homologous or identical twins come from the division of a single egg. Many facts point incontestably to this conclusion; among such are their morphological duplicity, their occasional conjoining as 'double monsters,' and a common chorion.³ Direct corroboration is furnished by the known manner of quadruplet development in the Texas armadillo, as well as by experiments and observations upon the lower vertebrates and invertebrates. Yet this specimen of human twins demonstrates for the first time their actual origin from a single yolk sac, and hence from a single ovum. Schwalbe's ('06) well-known reconstructions, based upon the Spee 1.54-mm. embryo, are purely hypothetical. Beside the present case, the only other illustrative specimens among mammals are the normal developmental stages of the Texas armadillo (Newman and Patterson, '10) and Assheton's ('98) single case of a sheep's blastodermic vesicle which bore twin germinal areas.

The second new twin specimen is in some respects even more interesting. Within the single chorion were twin embryos of 11.5 and 12 mm. (fig. 4). Each had its individual umbilical cord; these were attached to the chorionic wall, a quadrant's distance apart. Adherent to the amnion of one embryo (at the left in fig. 4) was a yolk sac of normal size; its cut stump may be seen in the photograph. The other embryo has no yolk sac. To make certain of this, both umbilical cords were sectioned throughout their lengths. That of the embryo at the left was typical for this age (fig. 5). The yolk stalk with its vitelline vessels lies in a coelomic extension; the level of the section here reproduced is too far distad to include the allantois. The cord of the embryo at the right is without microscopic trace of yolk sac or stalk, although the remaining structures are normal (fig. 6).

Certain deductions may also be made from this specimen. Mammalian monozygotic twins do not arise by the separation of early blastomeres, as too often has been assumed; on the

³ In another publication ('22 c) it will be shown that a common chorion is not infallible proof of the monozygotic origin of human twins.

contrary, the common chorion which all twins of this sort possess proves at once that separation must be subsequent to the period when the cleavage group is differentiated into an inner cell mass and an outer shell of trophoctoderm. That identical monochorionic twins arise by the fusion of separate ova need not seriously be considered, although it is apparent that some double ovum (fraternal) twins do become monochorial, in this way ('22 c). There is considerable evidence to support the belief that the twinning impulse occurs relatively late, at about the moment of gastrulation, which in mammals corresponds to the time of the formation of a primitive streak; the process, then, is simply one of double gastrulation. Studies on the development of the Texas armadillo (Newman and Patterson, '10) and Stockard's ('21) basic experiments and conclusions on the production of twins both substantiate this belief.

Exactly how determinate the mammalian ovum is in its development and how rigidly formative stuffs are localized are matters of speculation. The manner of fission into the two embryonic masses was presumably such that one received all, or essentially all, the cells destined to form a yolk sac; this again confirms the idea of a late moment for twinning when other cells had passed the stage of fundamental multiple potentialities.

The total absence of a yolk sac in one embryo which is otherwise normal in every way further demonstrates conclusively that this organ is not essential to the growth of an embryo or to the proper differentiation of its parts; indeed, the embryo in question is slightly larger than its twin, whereas both correspond closely in size to the norm for that menstrual age.

The embryo without a yolk sac is of further interest in relation to the ingrowth doctrine of vasculogenesis. In so far as such evidence is trustworthy, it supports rather the local-origin view, now generally acknowledged. That tiny vascular anlagen of yolk-sac ancestry actually existed and at an earlier moment helped form primitive vessels by extension into the embryo is, of course, conceivable; also the theoretical possibility of vascular ingrowths from the early anlagen in the body stalk are not excluded because of the characteristic and necessary nutri-

tive relations of the mammalian ovum. Fortunately, the fundamental truth of the local-origin doctrine rests on observations more rigorously controlled than this natural experiment which, however, was performed as perfectly as ever may be expected in a higher mammal.

In general, the yolk sac of man and the higher mammals appears to be an unnecessary vestige. In the earliest human embryos known, when it might be of real use, it is a simple entodermal sac containing masses of coagulum; growth to a conspicuous size is attained relatively late, long after adequate nutritional relations with the mother have been thoroughly established.

It is a great coincidence that both specimens of so rare a type should show features of such singular value and interest.

SUMMARY

Human identical or homologous twins for the first time are actually shown to originate from a single ovum.

The human yolk sac is a vestige unessential to growth or differentiation (including vasculogenesis).

The local-origin doctrine of vasculogenesis is supported within the limits of experimental possibility on mammals.

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PLATE

PLATE 1

EXPLANATION OF PLATE

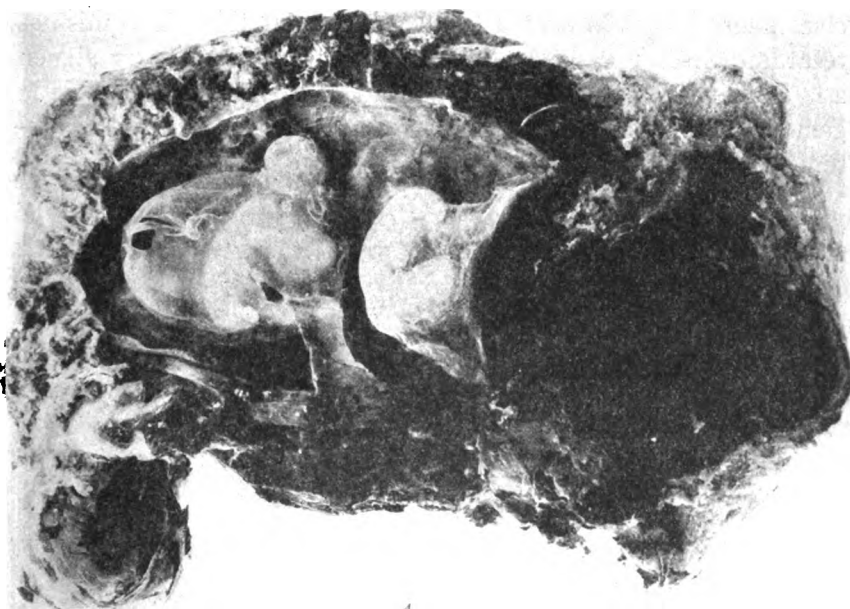
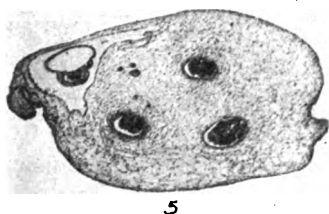
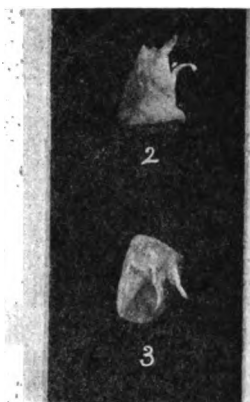
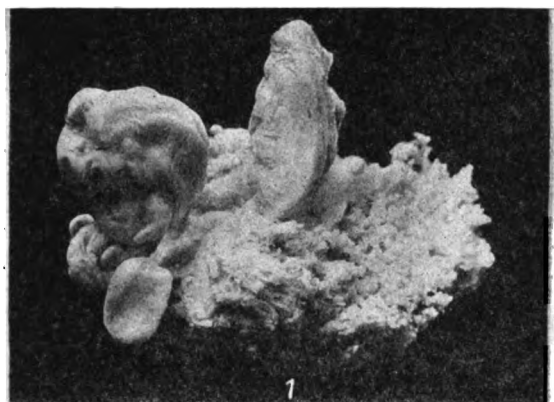
1 Photograph of 12.3-mm. human tubal twin embryos attached to a common yolk sac. $\times 2.2$.

2 and 3 Additional photographs of the common yolk sac shown in figure 1. The origin of the separate yolk stalks is apparent. $\times 2.2$.

4 Photograph of a pregnant human uterine tube. Part of the wall has been removed to show the twin embryos in place. The single yolk sac belongs to the 11.5-mm. embryo at the left. The 12-mm. embryo at the right lacks both yolk sac and stalk. $\times 1.7$.

5 Photomicrograph of a section through the umbilical cord of the embryo at the left in figure 4. The yolk stalk lies in a coelomic extension. The level is too far distad to include the allantois. $\times 23$.

6 Photomicrograph of a section through the umbilical cord of the embryo at the right in figure 4. There is no trace of a yolk stalk. The delicate tube below is the allantois. $\times 23$.



4

Resumen por el autor, Leslie B. Arey.

Fusión coriónica y gemelización aumentada en el oviducto humano.

Los datos que poseemos hasta el presente indican que la relación de los gemelos monocoriónicos y la de los dicoriónicos es unas quince veces mayor en el oviducto que en el útero. Los estados ilustrativos indican que esta desproporción de los ejemplares monocoriónicos resulta en parte de la fusión secundaria de los sacos coriónicos de los individuos dizigóticos. Por esta causa, en el caso del hombre, el término monocoriónico no debe usarse siempre para expresar el origen a expensas de un solo óvulo. Un factor todavía mas potente parece ser el aumento actual del impulso productor de gemelos. Su causa puede referirse más claramente a la inflamación tubal y sus resultados. Los mismos retardamientos y cesación del desarrollo que producen y siguen a la implantación tubal son responsables, respectivamente, de la gemelización excesiva y la malformación de los ejemplares obtenidos del oviducto.

Translation by José F. Nonidez
Cornell Medical College, New York

CHORIONIC FUSION AND AUGMENTED TWINNING IN THE HUMAN TUBE¹

LESLIE B. AREY

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FOUR FIGURES

INTRODUCTION

Monozygotic twins of the higher mammals are necessarily monochorial. It is likewise customary to accept a common chorion as proof that mammalian twins are identical or homologous, that is, monozygotic in origin. This, however, need not be an infallible criterion. One of the armadillos, *Dasypus villosus*, has usually two monochorial young at birth; Fernandez ('15) has shown that these embryos at first occupy individual chorionic vesicles which then progressively fuse until they appear as one (3.5-cm. stage). Fusion of twin chorions among ungulates is apparently common; Lillie ('17) has proved beyond doubt that only rarely does such union fail in twin cattle and that it also occurs in the sheep and hog. There are no other data known to me. Lillie expresses the following opinion (p. 400): "A number of mammalian groups could be at once excluded from consideration because the conditions of placentation are such as to prohibit chorionic fusion; in mammalian groups such as primates and many rodents in which the ovum becomes embedded in the uterine mucosa, there is, of course, an insuperable bar to early chorionic fusion." Nevertheless, in the human tube at least—and here, except spatially, the conditions of implantation are essentially identical with those in the uterus (Mall, '15)—indications of chorionic fusion occur. This truth became apparent during an analysis of the data accompanying the recorded cases of tubal twin pregnancy ('22 a). The supporting evidence will now be presented.

¹ Contribution no. 92.

STATISTICAL EVIDENCE OF CHORIONIC FUSION

First, the subject is best approached statistically. A rigid examination of the literature has revealed forty cases of tubal twins that appear authentic ('22 a); in addition there are eight cases which may be termed probable or presumptive. Among the positive list thirty-one specimens are recorded as having a common chorion, although apparently four more should be included, whereas in three only was it double.² In the probable group there are six definite statements; four of the six cases have double chorions.³ Combining both sets, the ratio becomes 33 (or possibly 37) : 7. To the list of double-ovum twins must be added those that develop bilaterally, one in each tube. There appear to be less than a dozen proved cases.⁴ Hence the total records show that monochorial specimens occur twice as frequently as the dichorial cases.⁵ Since, however, viable (uterine) identical twins are but one-seventh as frequent as the ordinary fraternal type, it follows that tubal monochorial twins are some fifteen times more common than might be expected if the tube were no more favorable than the uterus as a seat for twin production.

² In one of the three the evidence is not unequivocal for doubleness.

³ This relatively high ratio of doubleness is explained largely by the fact that duplicity itself was one of the determining factors utilized in rejecting several inadequately established cases from the positive group.

⁴ McDonald and Krieger ('13) collected the recorded cases of bilateral tubal pregnancy. They listed twenty-five proved cases, including both twin and successive specimens. Only in nine instances were both fetuses present and of the same age; in eight cases they were of different ages (including two with one member a mummy and one a lithopedion); two specimens had a fetus in one tube paired with a clot and villi in the other; in two cases there were clots with villi in both tubes. Twenty-seven additional cases were listed as 'probable but not proved'; as a matter of fact, in none of these instances was there positive anatomical evidence of bilateral gestation, either twin or successive; sixteen combined a fetus in one tube with a hematoma without villi in the other, while eleven were represented by hematomata in both tubes.

⁵ In this computation that group of dichorial cases which combine a simultaneous tubal and uterine pregnancy was, of course, ignored, for it belongs properly to neither category. Furthermore, comparable tubal conditions which allow one member of such pairs to descend uninterruptedly doubtless subtract a proportionate number from the monozygotic tubal specimens.

In view of these numerical relations, the preponderance of monochorial tubal twins seems to offer *prima facie* evidence of some modifying factor or factors. What these are will next demand consideration.

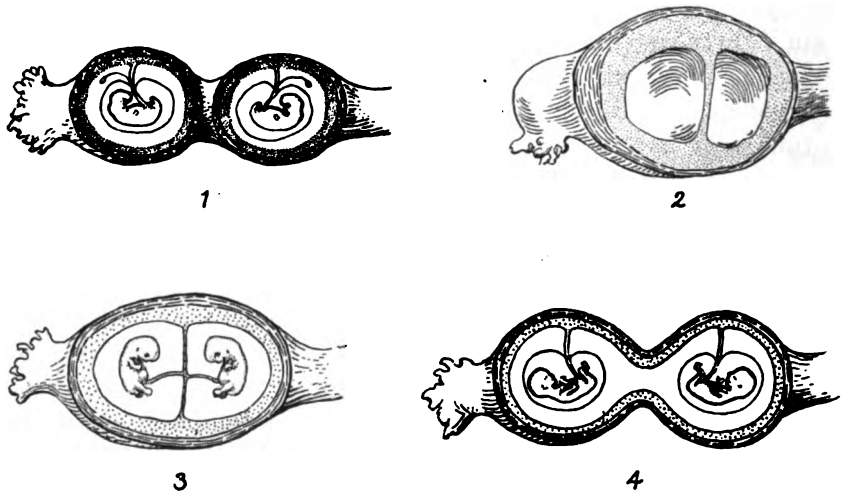
ANATOMICAL EVIDENCE OF CHORIONIC FUSION

The readiest explanation of the foregoing numerical disproportion is that separate ova have fused to produce pseudomonochoial twins. With this hypothesis in mind, the descriptions of all recorded cases of unilateral tubal twins were examined to ascertain if there is evidence of chorionic fusion in man. Briefly, such evidence does exist, as the following selected cases exemplify.

First in the series is Young's ('11) specimen, which comprises a tube with two dilatations; one represents a ruptured chorionic sac with its embryo still inside; the other sac was unruptured, entirely distinct from the first, and contained a twin embryo. Amann's ('08) case is apparently in the same category, and the clinical histories and anatomical descriptions recorded by Ferroni ('03), Saniter ('05), and Shauta ('05) make it probable that these also should be included. There is more doubt in the cases of Fenger ('91) and Salin ('95); they may be successive pregnancies. Figure 1 is a diagram of this preliminary condition based upon Young's specimen. Whether these particular ova ever would have fused had development continued or whether they were too far separated is unimportant; they typify the primary relation.

The next stage in fusion is illustrated by a tubal pregnancy described by Mall ('15) and Meyer ('20), listed in the Carnegie collection as no. 825 (fig. 2). Externally the tube bore a single swelling the size of a walnut, but section revealed two well-preserved chorionic vesicles, lying at about the same transverse level in the tube and flattened on the surfaces of mutual contact. The opposed chorionic faces had the appearance of a thin septum (Mall, pl. 9, figs. 4 and 5; Meyer, fig. 1), which proved to be double, partially separated by villi. Actual embryos and amnia had disappeared.

Pulcher ('05) has described a fusion still more advanced; it is a stage just prior to complete union (fig. 3). At the middle of the tube was a tumor the size of a fist. Its interior was divided by a thin translucent septum into two chambers, each of which contained a well-preserved 2-cm. embryo. Both umbilical cords were inserted near the center of the common septum. This partition was studied microscopically by sections; it is said to consist of a double layer of amnion. Nevertheless, since the umbilical cords pass to the septum, it must funda-



Figs. 1 to 4 Stages illustrating secondary chorionic fusion between dizygotic tubal embryos. Fig. 1, Young's specimen; fig. 2, Mall's specimen; fig. 3, Pulcher's specimen; fig. 4, Costa's specimen.

mentally represent a former double chorionic wall which had thinned and degenerated until it was no longer recognizable as such to the investigator.⁴ During the growth of these ova, the nutritional mechanism necessarily became progressively incompetent. Under these conditions, the embryos should be underdeveloped; in accordance with this expectation, we find the

⁴ Possibly the amnion was a constituent as well; each chamber is said to be lined with a 'smooth glistening membrane.' As this was the author's inaugural thesis, he presumably studied the specimen with care, although he failed properly to interpret the septum or the significance of the insertion of both umbilical cords in it.

menstrual histories indicating fetuses of twelve to fourteen weeks, when in reality they measure but 2 cm., which corresponds to seven weeks' normal development. It was a fortunate chance that the umbilical cords were inserted in the abutting chorionic walls; otherwise the specimen would have passed (as Pulcher believed) for twins with a common chorion and double amnion.

The final step in fusion is furnished by Costa ('07). Externally, the tube exhibited two dilatations, well separated and apparently distinct; internally, a neck-like constriction partially divided two communicating compartments, each of which contained a fetus, 5 and 5.3 cm., respectively (fig. 4). It is, of course, possible to interpret this as a single gestation sac secondarily constricted, but as it is a normal specimen, preceded by graded stages, fusion is more logical. The chances are greatly against the coincidence of single-ovum twins being so significantly spaced within a doubly dilated tube and chorion.⁷

Absolute proof of chorionic fusion waits upon the finding of male and female fetuses inside a common sac. Eventually such specimens may be confidently expected, especially since it is now possible to recognize sex in embryos as small as 15 mm. (Spaulding, '20).

In supplemental support of the principle of chorionic fusion, it is significant that two fetuses may occupy one gestation sac even when the history and anatomical relations point clearly to successive, rather than simultaneous pregnancies. Hence fusion, or inclusion, is certain. An illustrative case is that of Henricius and Kolster ('99), who attended a woman during two successive pregnancies without delivery on either occasion; at autopsy the left tube proved to be a single sac which contained a recent full-term fetus and a mass of fetal bones. A similar case is recorded by Racoviceanu and Bogdanovici ('04); the patient twice went to term without delivery; the right tube was a sac which contained a small, shrunken, but well-preserved fetus and an old lithopedion.

⁷ Mall ('15) has described rare cases of degenerating ova without embryos which assume an hour-glass shape during dissolution. This process has no relation to Costa's specimen.

In passing, it should be mentioned that the amnion of twins also join readily. Twelve cases in the twin series specifically mention this point; in eight specimens the amnion was single.

AUGMENTED TWINNING IN THE TUBE

Although chorionic fusion may be invoked satisfactorily to reduce in part the preponderance of monochorial tubal twins, it is pertinent to inquire if the relative frequency of monochorial tubal twins may not be largely explained by an excessive production of monozygotic twins rather than by the fusion of the chorionic sacs of dizygotic individuals. In order to return an answer, it is necessary to consider both the cause of twinning and of tubal implantation.

Stockard ('21) has been able convincingly to reduce the primary cause of all non-hereditary abnormal development, including true (monozygotic) twinning, to a single factor—developmental inhibition or arrest; the exact type of deformity that results depends solely on the precise moment when the interruption occurs. Thus, twin formation results from a slowing of the developmental rate at the time of gastrulation, which in mammals corresponds to the period of the primitive streak. Such an arrest allows other potential embryonic axes on the blastoderm to assert themselves, whereas in normal development they are dominated and suppressed by the chief axis. Direct experimentation on fishes refers the cause of arrest to retarded oxidations. Occasional twinning in the chick and the customary quadruplet formation in the Texas armadillo lend strong support to this view. Both are subject to arrest and reduced oxygen supply—the chick by a lowering of the temperature when laid, the armadillo blastocyst by a quiescent period of several weeks in the uterus before it becomes implanted.

The direct application of this fundamental concept to abnormalities and twinning in the human tube follows logically when once the conditions attending tubal implantation are known. Mall ('15) studied the extensive Carnegie collection of embryos, in which many clinical histories accompany the specimens. He concluded that tubal pregnancy is associated with

preceding inflammatory changes, usually of long standing. It appears that such inflammatory disturbances may continue over long periods during which the inflammation is constantly too severe to permit the germinal products to unite or maintain development; later, however, the condition may abate sufficiently so that the ovum can develop, at least for a time, although it is still incapable of reaching the uterus.⁸ Incidentally, it seems probable that if tubal pregnancy had not occurred in these cases when it did, the tube might soon have healed sufficiently to allow ordinary uterine gestation to proceed. The ovum fails to gain its normal destination in the uterus because of the impairment of the ciliated cells, as well as by kinkings of the tube through adhesions, by becoming trapped in epithelial diverticula of inflammatory origin or through adherent mucosal folds. "In short any change which delays the ovum in its progress will favor tubal pregnancy." An ovum taken up by the mucous membrane at the outer end of the tube may be delayed by the impaired ciliated cells until it is too large to pass the narrow end of the tube; it may wander into blind pockets or diverticula; more commonly still it is transported to the middle of the tube, where inflammation and follicular salpingitis are most common, and there become stranded because the ciliated cells can carry it no farther. Any of these delays, therefore, to which may be added the rarer hazards afforded by blind tubes, pocketed and double tubes, or delays due to migration from the opposite ovary, are the effective primary factors conditioning tubal implantation.

When the normal progress of the ovum is blocked in one of the ways designated it may then attack the tubal wall; in the meantime, however, it has attained a later stage of development than is customary at implantation. If, therefore, such delayed implantation and the establishment of tardy or inadequate oxygen relations (see below) should cause a developmental slowing at the critical moment for twinning, two embryonic axes would assert themselves as in the fish, chick, and armadillo, and mono-chorial twins result. This outline of events becomes a natural

⁸ In another publication ('22 b) I have shown that this sterile period averages nearly six years.

inference when Stockard's discovery is applied to the known condition of the tube and ovum in tubal pregnancy. It helps account rationally for the preponderance of single-ovum twin pregnancies in the tube, which, by its greater susceptibility to prolonged and slowly clearing chronic inflammation, further explains why the uterus bears relatively fewer monozygotic twins.

The theory of Stockard is further supported in its human application by the demonstrable frequency of faulty implantation in tubal cases and its relation to malformation of the parts. Mall failed to find a typical decidua here, and hence its function in checking hemorrhage by forming a dam between the tips of the villi and the eroded mucosa is foregone. There result numerous hemorrhages which form old clots between the villi. "Even the best of specimens frequently show such extensive hemorrhages around the chorion and such marked degeneration of the villi that it is a wonder that the ovum continues to grow normally." Checks, permanent or temporary, while the chorion is struggling to overcome natural deficiencies in its nidus are sufficient to account both for excessive twinning, if the delay prior to implantation be not sufficient, and for the observed double frequency of anomalies in these specimens over the uterine group.⁹

Mall held that the primary causative factor of these pathological embryos is faulty implantation which prevents an adequate transfer of nutriment. Stockard agrees with the primary factor, but from his experimentation is forced to attribute the proximal cause to inadequate oxygenation.

SUMMARY

The available data indicate that the ratio of monochorial to dichorial tubal twins is about fifteen times greater in the tube than in the uterus.

Illustrative stages indicate that this disproportion of monochorial specimens results in part from the secondary fusion of

⁹ Mall ('17) studied the anomalies of 1000 embryos and records that tubal monsters are twice as common as those in the uterine group.

the chorionic sacs of dizygotic individuals. Hence for man the term 'monochorial' need not always connote a single-ovum origin.

A still more potent factor appears to be an actual augmentation of the twinning impulse. Its cause is most clearly referable to tubal inflammation and its sequelae. The same delays and arrests which cause and follow tubal implantation are respectively responsible for the excessive twinning and malformation of tubal specimens.

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Resumen por el autor, C. E. Tharaldsen.

Una estufa de inclusiones en parafina para uso individual.

El presente trabajo es una descripción de la construcción y modo de funcionar de una estufa para inclusiones en parafina, adaptada para colocarla en una mesa de uso individual, la cual incluye facilidades para infiltración, inclusión, extensión de los cortes sobre porta-objetos, para secar, matar bajo la acción del calor, fijar y teñir en caliente, combinadas todas ellas en un aparato compacto dispuesto de tal modo que los objetos reciben el calor desde la parte superior del aparato y están situados convenientemente para el técnico. Las unidades que suministran calor consisten en dos bombillas eléctricas de 16 bujías, que pueden operarse por separado mediante una resistencia de cinco unidades, por medio del cual puede regularse la temperatura con rapidez y exactitud.

Translation by José F. Nonides
Cornell Medical College, New York

A PARAFFIN OVEN FOR INDIVIDUAL USE

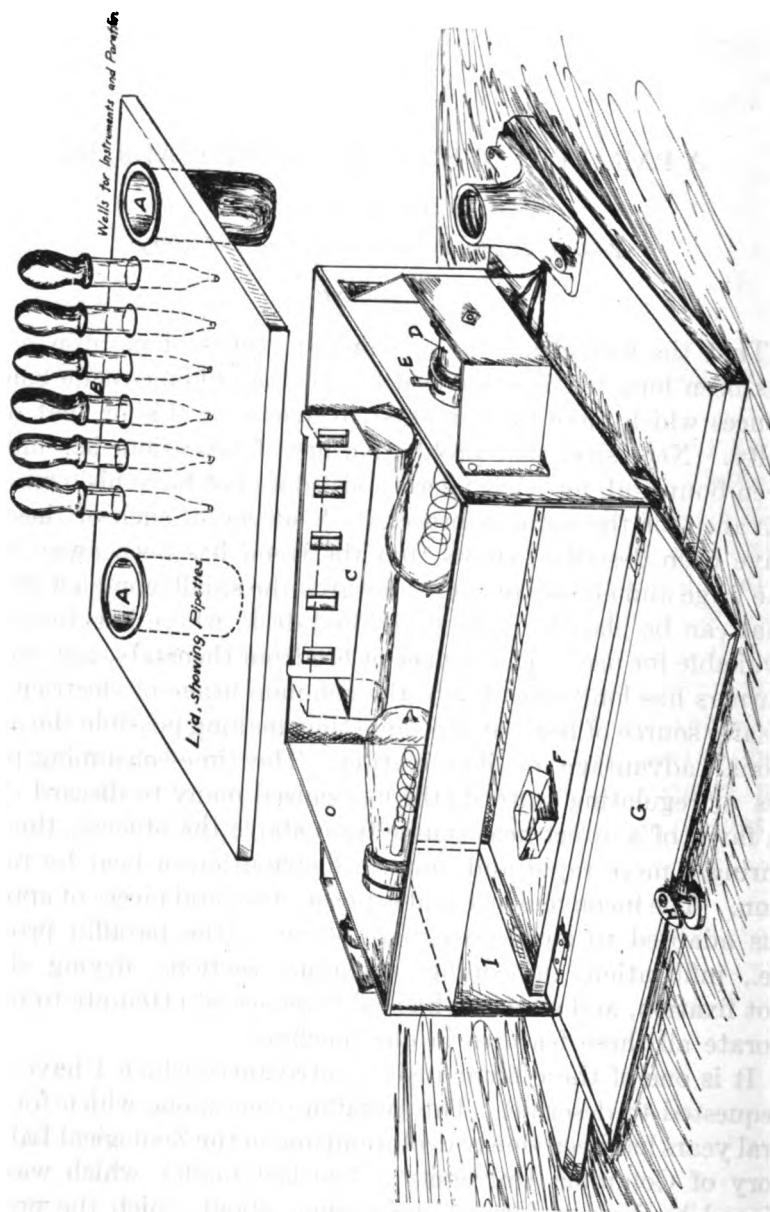
C. E. THARALDSEN

Zoological Laboratory, Northwestern University

ONE FIGURE

That the inefficiency of our common types of paraffin ovens has been long felt is evidenced by the many home-made contrivances which have been devised to overcome this or that difficulty. Necessity, that prolific mother of invention, has indeed been bountiful, for what microtommist does not have his own contrivance for the paraffin process! A survey of such of these as have been described shows that the trend has been away from the large and elaborate ovens, towards the small, compact device that can be placed on the individual desk, where it is instantly available for use. The danger of fire from rheostats, gas and oil burners has long since led to the common usage of electricity as a safer source of heat, at the same time making possible the additional advantage of illumination. The time-consuming process of regulating water-baths has caused many to discard these in favor of a direct heat source from above the objects, thus securing a more rapid and uniform distribution of heat by radiation. The inconvenience and expense of several pieces of apparatus adapted to some particular phase of the paraffin process, i.e., infiltration, imbedding, spreading sections, drying slides, hot fixation, and staining, has led to repeated attempts to incorporate all these features in one machine.

It is one of these home-made contrivances which I have been requested to describe. This paraffin oven is one which for several years has been slowly evolutionizing in the Zoological Laboratory of Columbia University. The last model, which was designed by Young, formed the nucleus about which the present oven was constructed. This model, constructed in the Zoological Laboratory of Northwestern University, has now been installed



in both of the above-named institutions as well as several others, as an oven for individual use. In its construction it embraces all of the above-mentioned principles in one compact apparatus, and in these institutions its efficiency has been demonstrated by thorough trial. Steps are being taken to have it patented, not for the purpose of exploitation, but rather to protect it from such, that it may be available at a minimum cost.

The oven consists of a rectangular metal box of firm construction, measuring 10" \times 5" \times 6", mounted on a wooden base. The heating unit consists of two carbon filament 16-c.p. electric lights, each mounted in a five-unit reductor control (*D*) which is regulated by means of a lever (*E*). These reductor units and levers for their control are located at the upper part of either end of the oven so that they are conveniently placed for regulation, and the whole is firmly supported and protected by guard plates. On the floor of the oven a movable tray (*F*) is fitted for containers of paraffin, etc. In this way an even distribution of heat is secured on the objects by radiation from above, and at the same time they are illuminated conveniently for manipulation. By means of levers the temperature can be regulated to suit the conditions demanded by the nature of the work, from that of slight warmth for drying purposes to beyond the melting-point of the hardest paraffin. Expensive and inconvenient thermostats, rheostats, and thermometers have been eliminated from the equipment as unnecessary.

The front of the oven consists of a door (*G*) which opens downward, the knob (*H*) of which is of such a length that the door when open lies on a level with the floor of the oven. This surface thus serves the purpose of a shelf on which the tray for paraffin containers can be moved out or in for greater convenience in transferring tissues, orienting objects, or for imbedding. It also serves as a secondary temperature control in short time infiltration for finer cytological work. On either end wall of the oven is located a metallic wing (*I*), which can be pulled out even with the tray on the surface of the door. This is for the purpose of protecting the paraffin from side drafts, should this be found necessary. For longer infiltration methods, such as

are required by some plant and larger pieces of animal tissues, the tray is left in place and the door closed, after which the temperature is regulated.

The top of the oven consists of a removable lid, in the rear corners of which are suspended two wells (*A A*), one for containing the stock paraffin and the other for holding needles and such other instruments as are used in work with paraffin. Thus the paraffin and instruments are conveniently accessible, and both, because of their location to the rear of the heating units, are kept at a temperature most favorable for such work.

Between these two wells are six holes (*B*) in which are suspended paraffin pipettes. These pipettes hang down into a trough (*C*) which serves the dual purpose of collecting paraffin drippings and of regulating the temperature of the pipettes for the paraffin work. For the latter purpose a series of vents are arranged on the rear wall of the trough which correspond to a similar set on the rear wall of the oven. The temperature of the interior of the trough is controlled by sliding the one series of vents over the other, thus regulating the size of the aperture.

The front two-thirds of the lid is flat and without obstructions. Its temperature can be regulated from high to low uniformly, or one side can be maintained at a higher temperature than the other by means of the levers at either end. This surface thus serves as a very efficient warm plate for the spreading of sections on slides without danger of melting the paraffin. It may also be used for hot staining on the slide without danger of boiling or burning, such conditions as are required by the carbol-fuchsin smear preparations of sputum or the Benda and Bensley methods.

For the rapid drying of sections on slides after spreading, the process is conveniently accomplished by placing the slides on cardboard, which is then placed on the tray, after which the door is closed to protect from dust, and the temperature is then regulated to a gentle warmth. The slides may be thus exposed indefinitely without danger.

Hot fixation and killing are accomplished by regulating the oven to the proper temperature and then placing the objects in a container of the desired fluid on the tray where it may be exposed for the proper length of time without danger of overheating.

For finer cytological work the oven has proved very efficient as a safe and convenient method for infiltration and imbedding. When exposure to xylol-paraffin mixtures is used, this may be accomplished on the tray as described above for hot fixation. The practice of passing the objects through several changes of paraffin may here be accomplished with all facilities conveniently placed and illuminated before the operator so that even a binocular microscope can be used when necessary, with the objects still under the proper temperature conditions. Square flat glass salt cellars are usually used as containers in this process. The button method of imbedding is facilitated if carried out on the tray where the temperature can be regulated so as to give sufficient time for the proper transfer and orientation of the objects before the paraffin is allowed to cool.

The parts of the oven are all demountable so that they may be readily removed for cleaning. Oil or gas burners or electric rheostats not entering into its construction has practically eliminated the danger of fire, and the oven may therefore be left in operation indefinitely with perfect confidence. Its light weight, compact and firm construction make it possible to transfer it with ease, and it can be kept on the individual research desk convenient for use without monopolizing this sometimes precious space.

Resumen por el autor, Bruno Oetteking.

Patelas anómalas.

Una indicación de la inserción del músculo vasto lateral en el lado supero-lateral falta raras veces en la patela o rótula. Las inserciones en este punto producen a veces profundas escotaduras o emarginaciones como resultado de la función muscular en conexión con procesos selectivos, tales como la economía en el material formativo y las influencias del medio ambiente que ejercen su acción sobre la textura del hueso. La emarginación está a veces ocupada por patelas accesorias ("patélulas"). Las condiciones patológicas y los huesos accesorios no son los agentes causantes de la formación descrita.

Translation by José F. Nonides
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ANOMALOUS PATELLAE

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FOUR TEXT FIGURES AND ONE PLATE (TWO FIGURES)

Of the few anomalies met with in the human patella, that of emargination is not at all scarce. It occurs invariably on the upper outer margin of the bone, taking on a great variety of form, particularly with regard to the extent and depth of the incisure produced by the emargination. While only the extreme cases of emargination are of interest to the anthropologist, it may be well to reflect first upon the anatomical significance of the anomaly. The latter is preëminently to be understood from the mechanical or functional angle, and as such is closely involved in the articulation of the knee-joint. It has been shown that during the act of flexion the patella moves laterally under duress of the trochoginglymus character of the knee-joint, to assume an external position in complete flexion, i.e., a position in front of the lateral condyle of the femur. In this position only a narrow marginal area on the medial side of the articular surface of the patella is in touch with a similar marginal area on the lateral tibial surface of the medial condyle of the femur, forming here a distinct facet of semilunar or crescentic shape. The strain of flexion is withstood by the patellar ligament, the prolongation of, and continuous with the common tendon of *m. quadriceps femoris* and inserted in the *tuberositas tibiae*. It is this direct strain that in flexion somewhat sidetracks the patella laterally. The main agent here, as Kempson ('02, p. 420) has shown, is the tendon of *m. vastus lateralis* inserted into the upper portion of the lateral margin of the patella, in coöperation with the *tractus iliotibialis* and the *retinaculum patellae laterale* (fig. 1).

As to the variableness of insertion, there is hardly a patella found without showing at least an indication of it, quite frequently in such a case in the shape of a smooth and slightly depressed or semilunar edge of about 1 cm. or more in extension. Todd and McCally ('21), who have examined 682 skeletons, state that there

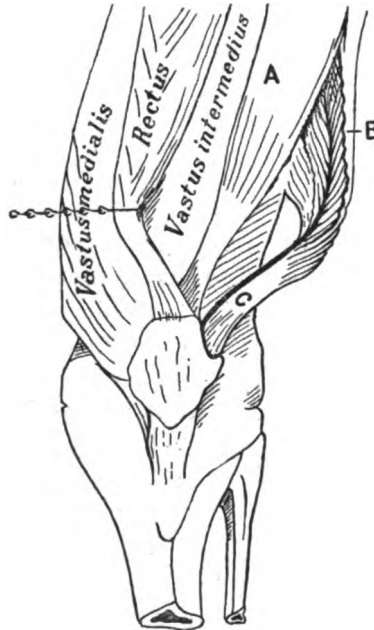


Fig. 1 The insertion of *m. vastus lateralis*. The upper part, *A*, of the muscle is divided from the lower part, *B*, by a longitudinal incision. The muscular fibers are seen inserting into the two surfaces of the tendon, *C*, which is inserted in the superolateral margin of the patella (modified after Kempson).

are "about three per cent of human beings characterized by more or less marked defect of the upper and outer part of the bone." This is a rather low occurrence, but of significance in view of the large material investigated. Pronounced cases of emargination with hook or spine-like projections are sometimes the result of multiple patellar formation, as pointed out by Wright ('04), who says on page 66:

The explanation which I have to offer for the emargination to the patella is that in addition to the central deposit of cartilage cells in the quadriceps extensor tendon which forms the patella, we not infrequently get an outlying deposit in the anterior fibers of the ilio-tibial band of fascia lata; that this deposit when it occurs is usually small; that it joins the central deposit, its presence being indicated by the process which gives to the patella its occasional emarginated appearance.¹

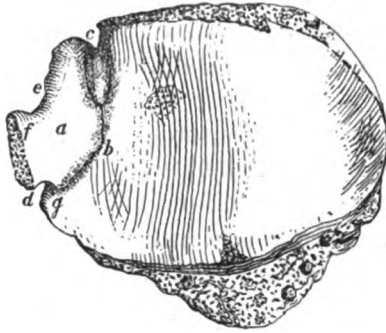


Fig. 2 Articular surface of a patella from Santa Catalina Island, California (no. 609). *a*, accessory patella ('patellula'); *b*, furrow caused by the coalescence of the patella and 'patellula'; *c* and *d*, upper and lower clefts of incomplete coalescence; *e*, insertion line of *m. vastus lateralis*, continuous with *c*; *f* and *g*, spine-like projections at lower ends of patellular and patellar notches.

That this assertion is exactly to the point in certain cases is demonstrated by a left patella in our collections from Santa Catalina Island, California (no. 609), which may be seen illustrated in figure 2. The bone shows on its upper lateral side an unevenly lozenge-shaped accessory 'patellula' (*a*), whose articular surface is set off against the articular surface of the patella proper by a distinct, but otherwise smooth and fairly deep furrow (*b*). The two elements are incompletely coalesced above and below, leaving in these two places distinct and relatively deep clefts (*c* and *d*). The anterior patellular surface, somewhat circular, is slightly bulged and rugged in continuation with the patellar sur-

¹ Pearson and Davis, in a comprehensive comparative study on the sesamoids of the knee-joint, assert that "in the knee-joint itself we have come across no less than ten sesamoids" ('21, p. 134), which are fittingly named by them in accord with the older nomenclature.

face, against which it is set off only by a somewhat broad and shallow depression. The anterior surface of the accessory bone is at 23 mm. almost doubly as wide as the posterior or articular one at 13 mm., while its height measures 22 mm. But the more important point here is that the 'patellula' is deeply set into a notch of the patella proportionate to the former's size. Although the theory of accessory patellae as advanced by Wright is plainly demonstrated by the case just described, it seems to be doubtful to the present writer whether the more or less spine-like projections at the lower end of the emargination unimpaired by the accessory element is due to the same origin. In none of the cases that came to his attention has he seen a demarking furrow or an indication of it between the spine and the bone proper comparable to the condition mentioned in connection with the area of coalescence between the patella and 'patellula' just described (no. 609). And again is the patellar notch, for instance, in the case to be described below, considerably deeper than simply to be caused by the spine-like projection in justification of Wright's assertion that, "the process gives to the patella its occasional emarginated appearance," which at best might only serve to emphasize the emargination. This is furthermore proved in figure 2, *c-e*, where the insertional line of the vastus lateralis muscle continues from the patella proper upon the 'patellula,' thereby transgressing the upper cleft of incomplete coalescence (*c*), and forming a spine-like projection of its own at the lower end of the patellular insertion (*f*). But the lower termination of the patellar notch that lodges the 'patellula,' also projects spine-like (*g*), and although not coalesced with the 'patellula,' the outlines of the latter and the patellar projection are continuous over the lower cleft of incomplete coalescence (*d*) to form the lateral boundary of the common articular surface. A coincidence like this in the formation of similar projections in analogous and near-by places is hardly conducive to assuming their origin from specific accessory elements. There is, however, a patella figured by Todd and McCally ('21, pl. II, no. 10), in which the spinous process at the lower end of the emargination seems to be of an accessory nature, since a distinct furrow divides the two elements, the process and the bone.

The patella in our collections (no. 697, from Chihuahua, Mexico) that called for a special investigation on account of its deep superolateral notch is rather delicate, medium sized, and of somewhat rounded or, still better, broad oval-shaped appearance. It may be seen in plate 1, as figure 5, *a* and *b*, sided with the patella just described and enumerated as figure 6, *a* and *b*. It is a left patella. Its anterior surface shows the longitudinal ridgings peculiar to this bone, and as many as twelve more or less distinct nutrient foramina. On the basis is seen the typically smooth and fairly deep horizontal groove of insertion, while the

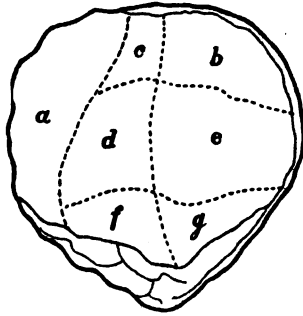


Fig. 3 Articular surface of a right patella (after Luther Holden). *a*, *b*, in contact with femur in complete flexion; *b*, *c*, in contact with femur in rectangular flexion; *d*, *e*, in contact with femur in semi-extension; *f*, *g*, in contact with femur in complete extension.

apex, bluntly pointed, appears to be smoothed down in front. On the articular side the basal margin is slightly turned inward toward the articular surface, while the rugged apex recedes from the articular surface medially to the amount of 5 mm., its lateral region being almost on a level with the articular surface. The facies articularis itself shows the typical slopings from a vertical ridge, the crista faciei articularis, toward the medial and lateral borders, to form its larger lateral and smaller medial portion. The facetation of the articular surface is also in evidence, particularly the medial vertical facet, which is markedly concave from side to side at a width of about 9 mm. and an approximate depth

of 2 mm.² The outstanding feature of this patella is the deep notch which at its lower end is pyramidally pointed, to form a spine-like projection. At its bottom the notch is considerably roughened, baring here the two compactae and the intermediate spongiosa. The deepest place is situated at about the level of the horizontal halving line of the entire bone, or, counted from below, between the first and second thirds of the articular surface. The anteroposterior diameter between the margins of the notch amounts here to 9 mm. The distance between the two foot-points of the curve demarking the outline of the emargination measures 21 mm., while its depth comes to 5 mm. This is quite

² Besides H. Meyer ('53) it was John Goodsir who really seems to have been the first to bring conclusive evidence regarding the principal stations in the articulation of the knee-joint as expressed by certain definite marks on the cartilage of the articular surfaces, particularly of the patella. As his elaborations on the subject are of fundamental importance, but on the other hand rather difficult of access, the reprinting of part of his article may be welcome here. The present writer has supplemented it for visual information by a diagram (fig. 3) after Luther Holden (*Human Osteology*, London, 1899, 8th edition, fig. 13, p. 215).

John Goodsir ('68, pp. 224-226) writes: "The patella exhibits various interesting relations during the movements of the joint; and in addition to those observed by Meyer, others hitherto unrecorded may be pointed out. Meyer states that the under half of the patella is in contact with the femoral trochlea in extension, and the upper half in flexion; but if the bones are carefully examined, the following configuration and relation of its articular surface will be detected. Instead of two faces, a greater external, and a lesser internal, separated by a perpendicular ridge, as usually described, the surface presents, in every instance, six, frequently seven, facets, separated from one another by two perpendicular and two transverse ridges. The external perpendicular ridge is the one commonly described. The internal cuts off a small elongated perpendicular facet at the inner edge of the surface. The two transverse ridges only extend inwards to the inner perpendicular ridge, so as to separate from above, downwards, two superior, two middle, and one or two inferior facets, the external of the two latter being constant. The relations of the articular surface of the patella present four groups. In complete flexion, the internal or perpendicular facet is in contact with a remarkable crescentic facet, which bounds the oblique curvature of the inner condyle of the femur. In none of the other positions of the joint is this internal patellar facet in contact with an opposite cartilaginous surface, but is covered or sheathed by what may be denominated the internal patellar pad. At the same time, the external superior facet lies upon the fore part of the external condyle of the femur below and behind its bounding groove. These two facets are the only parts of the patella which come in contact with the proper femoral condyles. They do so only in complete flexion: and in this state all the remaining facets are in contact with the great infrapatellar pad, and the so-called mucous ligament.

considerable and becomes still more evident in comparison with the Krapina patella (Gorjanović-Kramberger, 1906, 239) whose outlines are seen sided with the Mexican one under discussion in figure 4, *a* and *b*. The absolute diameters of the two bones differ mostly in the height and thickness and may be studied from the adjoined comparative table, wherein the Spy measurements from the same publication by Gorjanović-Kramberger (p. 239) are also listed. The upper external portions of the margins of the Mexican and Krapina bones, as seen from their posterior or articular surfaces, are drawn in figure 4, *a-c*, first singly and then in superimposition, coinciding on their lines of deepest emargina-

"In the second stage of extension, the superior internal and external facets are in contact with the inferior portions, respectively, of the inner and outer halves of the femoral trochlea; the internal perpendicular facet being sheathed as before stated, and the remaining facets being in contact with the great infra-patellar pad.

"In the third stage of extension, the superior internal and external facets leave the femoral trochlea and become sheathed, and the space occupied partly by the supra-patellar, but principally by the supra-trochlear pads. The middle internal and external patellar facets now come in contact with the middle portions respectively of the inner and outer halves of the femoral trochlea; while the internal perpendicular and the two inferior facets are sheathed and padded as before.

"In the fourth or last stage of extension, the middle internal and external facets also recede from the surface of the trochlea, and along with the internal longitudinal already sheathed become applied against the fore part of the femur above its articular surface, the intervening space being stuffed by the supra-patellar, supra-trochlear, and upper pads, in the ascending cul-de-sac of the synovial membrane. In this last stage, the only portions of the patella in contact with the cartilaginous surfaces of the femur, are the inferior internal and external facets, or the latter, if one only exists. These slip somewhat abruptly upwards and inwards upon a narrow ledge or furrow, which terminates the femoral trochlea above, and forms a resting-place for the inferior facets of the patella in the complete extension of the joint."

The six or seven articular facets which Goodsir points out as typical in the European patella are naturally somewhat blurred in the dry bone. In the recent state, however, they are quite marked in the thick layer of cartilage that covers the posterior surface of the patella, the thickest in fact, in the entire skeleton, attaining a thickness of from 5 to 6 mm. over the crista verticalis. The number of articular facets does not seem to be constant, however, and their shaping is subject to the influences of function. In this respect, Lamont ('09/'10) found the medial perpendicular and particularly the lateral superior facets enlarged in the Punjabi as a result of squatting. The author appends that the same condition has been stated by Macalister as "very common in ancient Egyptian patellae."

tion. These latter measure 2 mm. and 5 mm., differing by 3 mm. in favor of the Mexican patella. It will be readily seen that the extent of the curve describing the emarginations is also greater in the latter bone where it amounts to 21 mm. against 11 mm. in the Krapina bone.

	PATELLAR MEASUREMENTS		
	Mexico	Krapina	Spy
	mm.	mm.	mm.
Width.....	44	49 46.6	51.4
Height.....	42	42.3-44.4	46.3
Thickness ¹	19	23.2-42.0	22.2-24.0
Dimensions of articular surface:			
Height.....	25		
Width.....	44		
Dimensions of emarginations:			
Length.....	21	11 ²	
Width.....	9		
Depth.....	5		
Angle of articular surfaces.....	124(129°) ³	109-110°	119°

¹ Gorjanović-Kramberger ('06, 239) lists: 'Dicke der Mitte,' but as the maximum diameter anteroposteriorly is generally found in the middle, this method should not deviate from that of the present writer's.

² Author's measurement on diagram.

³ The lower figure was attained by resting the two feet of the coordinate calipers in the lateral depressions of the articular surface of the patella about coinciding with its horizontal bisector; the higher one by using the extreme margins of the articular surface, while in both cases the coordinate branch was lowered on the longitudinal crest (*crista faciei articularis*), the latter's height amounting to 9 and 10 mm. in the two cases. The proportions were then transmitted on paper and the angles measured. As regards the Spy-angle, Gorjanović-Kramberger says that it was measured 'bei der Basis,' yielding a figure then that is not directly comparable to the Mexican ones.

It is quite probable that cases of extreme emargination occur individually as a direct result of function, since man's lower limb is, with regard to the kinetics of his entire skeletal system, the most intensive functioning portion. Pathological causes, such as trauma and inflammatory processes, are fairly out of consideration here and are also dismissed as unjustifiable by Todd and

McCally ('21, p. 781), who, with regard to the causation of patellar defects, speak of various phases of an anomaly of patellar ossification. There is, however, another moment that may not be overlooked, namely, nature's apparent tendency toward economy in formative material. In the higher types this gives rise to the formation of muscle marks, such as tuberosities, ridges, and the like, which in the inferior types and the anthropoid apes are frequently seen only sparsely developed, a greater amount of osseous mass taking the place here of more differentiated conditions. Still another consideration would be that with regard to the bone whose less resistive qualities as a result of the influences

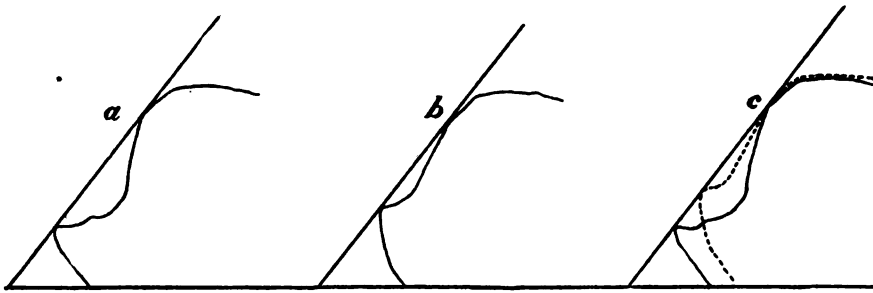


Fig. 4 Comparison of outlines showing emarginations of: *a*, the Mexican; *b*, the Krapina patella; *c*, superimposition of *a* and *b*. Natural size.

of more refined environmental conditions might, in conjunction with the above-named economy in formative material, be responsible for the specific relief known as muscle marks. Under that consideration a muscular insertion might eat itself deeply into certain bones like the patella to form the deep notch found there at times.

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PLATE 1

EXPLANATION OF FIGURES

Anomalous patellae, figures 5 and 6, *a* and *b*, represent the articular and anterior surfaces of two anomalous patellae from Chihuahua, Mexico, and Santa Catalina Id., California, the former marked by a deep insertional notch, the latter by an accessory bone ("patellula") filling up to the greater part a well marked notch.

a



5

b



a



6

b



ON AN ANOMALOUS DIGASTRIC MUSCLE IN THE THIGH OF A CHINESE

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ONE FIGURE

Failure to find in the literature any citation of the following variations in the musculature of the lower extremity suggests the value of placing the present case on record. From the standpoint of ontogeny, the relations found present a picture of such unusual interest that a brief discussion of the developmental factors concerned is also included in this report.

DESCRIPTION

The anomalies to be described represent the most important of several observed during the dissection of a male Chinese, age 39. An enumeration of the other abnormalities observed in this same body is appended at the end of this report.

Lying beneath the long head of the biceps femoris and roughly bisecting the angle between that and the short head, there was discovered a third distinct, though smaller head to this muscle. The fibers of this supernumerary muscle slip, which measured approximately 15 cm. in length and from 3 to 5 cm. in diameter, converged proximally into a small tendon which passed out of sight in the earlier stages of the dissection between the peroneal and tibial divisions of the sciatic nerve (fig. 1). At the same time there was observed a smaller cord-like tendon emerging from beneath the lower border of the glutaeus maximus above and passing distomedially toward the deeper structures of this region of the posterior thigh. Although the course of this latter tendon formed a distinct angle with that of the tendon arising immediately from the supernumerary head of the biceps, yet

manipulation and subsequent dissection proved their continuity one with the other. In brief, the tendon of this anomalous muscle, continuing proximally from the distodorsal position of

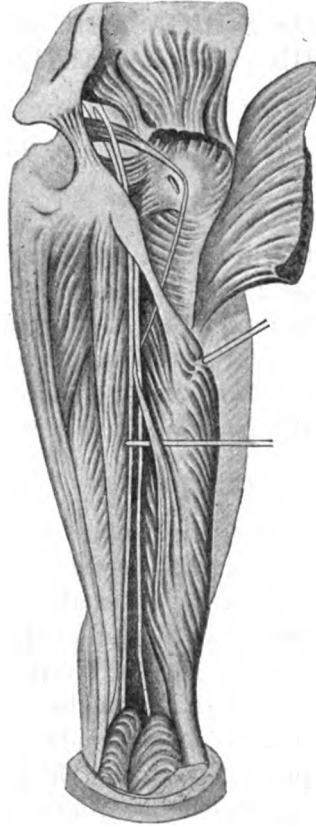


Fig. 1 A semidiagrammatic drawing of the posterior musculature of the thigh in which the anomalous digastric muscle appeared, showing the relations of the two muscle bellies to the piriformis and the biceps, respectively, as well as the relation of the intervening tendon to the peroneal division of the sciatic nerve and to the greater trochanter.

the muscle below, passed dorsoventrally around the medial side of the peroneal nerve and, after becoming loosely associated with the fibrous tissue investing the divided sciatic nerve, changed its course from a slightly medial to a slightly lateral direction (fig. 1).

Upon reflecting the *glutaeus maximus* muscle and tracing the proximal portion of this anomalous tendon to its origin, it was observed to be associated with the capsule of the bursa lying between the *glutaeus maximus* and the greater trochanter (*b. trochanterica m. glutaiei maximi*).

Careful dissection of the origin of the above tendon and examination of the relation of its fibers to those of the superficial layer of the bursa capsule revealed the fact that the tendon did not end there. Although sending out several diverging strands of fibers which became intimately incorporated in the capsular connective tissue, the tendon itself remained more or less distinct from the structure of the capsule and continued across it as a conspicuous though slightly flattened band (fig. 1).

The subsequent course of the tendon after leaving the surface of the bursa capsule at its proximomedial border was directed strongly medialward. The tendon now ran roughly parallel to the lower border of the *piriformis* muscle, being separated from the latter by a well-defined space of from 1.5 to 2 cm. above as well as by an interval corresponding to the thickness of the dorsal margin of the greater trochanter ventrally. In the case of the left side this tendon remained a fibrous cord throughout the rest of its course. On the right side, however, the tendon served as the attachment of a small muscle slip, from 1 to 3 cm. wide and approximately 10 cm. long, which passed ventral to the peroneal nerve and then between this and the tibial nerve as these emerged as separate nerve trunks from the pelvis, thereby duplicating in respect to the peroneal nerve the relations of the distal portion of the tendon below the capsule (*v. supra*). This proximal muscle slip continued medially to its origin on the anterior aspect of the third and fourth sacral vertebrae and from the dorsolateral surface of the sacrospinous ligament.

These two aberrant muscle slips were innervated by a twig from the tibial and a small branch of the anterior division of the second sacral nerve, respectively.

DISCUSSION

The embryological interpretation of the anomalous condition just described is not at once obvious. A brief discussion of some of the more relevant factors involved may therefore be considered not out of place.

In the first place, it may readily be suggested that we are dealing simply with two aberrant muscle slips—arising from two well-defined muscle entities, viz., the biceps femoris and piriformis muscles, known in each case not infrequently to give rise to supernumerary slips—whose tendons have secondarily become associated with each other in the connective tissue overlying the greater trochanter as described above. Testut,⁹ Schaeffer,⁸ Frohse and Fränkel,⁵ LeDouble,⁷ and others have not only reported original cases, but have compiled long lists of supernumerary heads and aberrant slips observed in connection with the biceps femoris. To them the reader is referred for a detailed enumeration of these cases. When these reports are closely analyzed, however, and due allowance made for differences in terminology and interpretations, it is found that the range in variation in the origin and insertion of such slips is not wide. Testut (l.c., p. 993) summarizes the eight or nine distinctive types reported in the literature up to 1911 as follows:

“Le muscle biceps peut être renforcé par des faisceaux surnuméraires, provenant suivant les cas: 1° du condyle externe (Gruber); 2° de la partie supérieure de la ligne âpre (Meckel); 3° de la ligne rugueuse qui réunit le grand trochanter à la ligne âpre (Giacomini); 4° du fascia lata (Henle); 5° du vaste externe; 6° du grand adducteur.—J’ai observé chez un nègre (Dissection d’un Boschiman, in Arch. du Muséum, 1885), un faisceau surnuméraire, de forme triangulaire, qui partait du coccyx pour aller grossir la masse commune du biceps et du demi-tendineux.—Turner a signalé (Jour. of Anat. and Phys., 1872), sous le nom de tensor fasciae poplitealis, un petit faisceau musculaire qui se rendait du biceps à l’aponévrose poplitée.—Des faisceaux plus singuliers encore, se rendant du biceps au tendon d’Achille et au calcaneum, ont été observés par Kelch (Beitr. z. path. Anat., 1813), par Gruber (Beobacht. aus d. menschl. u. vergl. Anatomie, Heft. II, Berlin, 1879) et par Halliburton (Jour. of Anat. and Phys., 1881).⁹

Careful reading of the original of as many of the above references as were available, not only for the particular variation reported in each, but also for the review of such supernumerary slips of the biceps femoris in general that is usually contained in these writings, failed to reveal, however, any record of such an aberrant head taking origin from the fascia (either entering into the formation of the bursa capsule or otherwise) over the greater trochanter. Of the possible exceptions to this, the cases of the Giacomini and of Henle quoted by Testut (v. supra) seem to refer in the first instance to a definite bony origin from a line on the femur between the greater trochanter and the linea aspera, evidently a slip from the short head of the biceps having an independent origin slightly proximal to the usual origin of that head on the linea aspera, and in the second instance to a more superficial fascial slip from the fascia lata to the long head of the muscle. LeDouble (l.c., p. 281) also mentions a supernumerary fascial attachment "*de la face profonde du grand fessier, à quelques centimètres de ses insertions iliaques*" which, although associated with the fascia of the deep surface of the gluteus maximus, seems to be distinct from the instance herewith reported.

The second muscle slip with which we are concerned in the present view of the anomaly is the proximal fleshy termination of this aberrant tendon. Continuing medially and proximally from the trochanter and passing ventral to the peroneal nerve and then dorsally between it and the tibial nerve trunk to its final origin from the sacrum, this muscle slip would probably be considered in such a scheme simply as a divided portion of the piriformis. Both in point of origin and in its relation to the two divisions of the sciatic nerve this muscle slip qualifies well for such a classification, and the condition, if indeed this is the condition with which we are dealing, is found frequently enough to warrant the statement that it occurs normally in about 20 per cent of all cases.⁴ Such divisions affect only the proximal portion of the muscle, however, and almost invariably reunite with the main piriformis muscle tendon to become inserted with it upon the anterior and inner portion of the upper margin of the

greater trochanter. A complete separation of such slips from the usual fibers of the piriformis at the point of their insertion, on the other hand, and a subsequent migration of their insertion from the inner aspect of the trochanter downward and outward to a position on the lateral side of the trochanter, as apparently has occurred in the present case, has never been noted in the literature as far as the writer has been able to ascertain. Upon the occurrence of a continuation of such an aberrant tendon from the piriformis with an equally aberrant tendon which has reached the same point from the biceps femoris below, the literature is similarly silent. The difficulties in the way of supplying this latter phenomenon with a logical developmental background are obvious.

The second view of the anomalous condition as observed in this case suggests that we are dealing with a single developmental anomaly resulting in a compound muscle of digastric form. The early work of Bardeen and Lewis¹ and the later studies of the former² leave little doubt that the anlagen of such muscle aberrancies as those with which we are here dealing become differentiated as such, either during or very soon after the period of general differentiation of muscle groups within the primitive myogenous zone of the limb. Unfortunately, none of the excellent figures in the articles just referred to were drawn from an angle showing the respective anlagen of both the biceps femoris and the piriformis at the same time. A careful study of these figures of actual reconstructions of the developing nerves and muscle of the lower limbs in very early human embryos, however, gives good evidence of two facts having a direct bearing on the possible formation of the anomaly in question.

In the first place, in the still undifferentiated myogenous zone of the limb bud up to the 7- or 10-mm. stage, those concentrating areas of cells which are destined to differentiate later as the specific anlagen of the biceps and piriformis muscles lie very close together. The only structure intervening in the following stages of progressive differentiation in this region is the outgrowing sciatic nerve trunk. This means that in those cases where the sciatic nerve, either as a whole or in part, pierces the piriformis

muscle a portion of the anlage of this muscle is still less definitely separated from that of the biceps which lies immediately adjacent. Such a split-off portion of the piriformis anlage, as mentioned above, almost invariably again associates itself with the main body of the muscle to become incorporated in the common tendon of insertion, after transmitting a portion or all of the sciatic nerve through the resulting proximal hiatus. Failure to reunite with its parent anlage, however, would present the alternative possibilities either of an independent existence or of an association with a neighboring muscle anlage. Both of these fates of aberrant slips from the piriformis are apparently rare in man, but that such an association with the adjacent biceps sometimes occurs in the case of lower forms may account for the original opinion of Gegenbaur* (since corrected by later observers), that the piriformis was derived from the caudofemoral muscle of urodeles—a muscle represented in many mammals by a caudofemoralis extending from the caudal vertebrae to the lateral side of the distal half of the femur.* The writer believes that the present case represents an example of such an association between a separated portion of the piriformis anlage and that of the biceps femoris in man. The picture in this case is somewhat complicated by an intervening attachment over the greater trochanter, which will be discussed below, but it is altogether probable that the case of a sacral attachment of the biceps attributed to Macalister (original reference not given) by LeDouble (i.e., p. 281) represents an uncomplicated case of such an embryonic association between these respective muscle anlages.*

The second relevant fact derived from a study of the reconstructions of early human embryos referred to above is the relations of the developing skeletal elements in the primitive scleroblastema with reference to the two muscle anlages dis-

* The sacral attachment of the biceps here under discussion must not be confused with the frequent fasciculi from the coccyx, sacrum, or sacrotuberous ligament to the long head of the biceps, giving rise to the opinion of some investigators that the long head of the biceps represents a muscle primitively arising from the sacrum or coccyx and that the sacrotuberous ligament represents a transformation of that part of the muscle originally extending between the sacrum and its present origin from the ischial tuberosity.

cussed in the preceding paragraph. These are more clearly emphasized in the further studies of Bardeen devoted entirely to the development of the human skeleton. Up until a stage of development represented by a 14-mm. embryo (embryo CXLIV, pl. III, figs. 5 and 6, Bardeen²), or considerably after the beginning of the muscle-anlage differentiation, the developing femur has maintained its primitive position in relation to the pelvis. At this time the shaft of the femur lies approximately at right angles to the body axis and extends directly into the hip-joint. Here there is no neck, merely a simple rounded head, distal and dorsal to which a slight projection marks the beginning of the greater trochanter. Thus the primitive anlage of the trochanter lies not only in direct line, but also practically in the same plane with the two muscle anlages discussed above. The possibility of a secondary association between the aberrant muscle-slip anlage herewith implied and the developing trochanter lying immediately ventral to it would be enhanced in the case in question by the tendency naturally inherent in any divided portion of the piriformis to seek an attachment on the trochanter.

By the time the development of the embryo has progressed to a stage represented by one of 20 mm. (embryo XXII, pl. IV, figs. 9 and 10, Bardeen²), the trochanter is not only clearly differentiated as such, but has also rotated lateralward from its more primitive position. This lateral rotation and subsequent shifting of the trochanteric region incident upon the progressive development of the future conformation of the proximal end of the femur, dragging with it the blastemal attachments already formed—which in the case in question would include that of the aberrant muscle anlage bridging the gap from the piriformis above to the biceps below—would account for the picture presented in adult life (fig. 1).

The writer is led to suggest this second interpretation, therefore, as the true explanation of the appearance of this muscle of digastric form in the musculature of the posterior region of the thigh of this Chinese subject. Rather than with two aberrant muscle slips arising independently from distinct and widely separated muscle entities, effecting a unique union after pursuing

courses equally unusual, it seems more probable that we are dealing with the development of a single muscle anlage, the central and later tendinous portion of which early became associated with an adjacent skeletal element whose subsequent rotation from its primitive position obscures somewhat the fact of the essential continuity of the widely separate muscle bellies.

In addition to the anomaly reported above, the following were also observed in this same subject: 1) excessive size of the peroneus tertius muscle in both legs; 2) absence of the tendon of the flexor digitorum brevis usually passing to the little toe; 3) supernumerary slip arising from the tendon of the flexor digitorum longus beneath the lacinate ligament and dividing into two tendons inserting into the lateral side of the flexor digitorum brevis and the second phalanx of the fifth toe, respectively; 4) total absence of the plantaris muscle on the left side and its reduction to a fibrous cord on the right; 5) the anterior trunk of the seventh cervical nerve joins that of the eighth to form the medial cord of the left brachial plexus, while on the right side the anterior trunk of this same nerve divides into two divisions of approximately equal size joining the lateral and medial cords of the plexus, respectively; 6) supernumerary heads of both biceps brachii arising in each case from the middle third of the medial side of the humerus; 7) a small aberrant muscle slip in the right forearm, having its origin in common with the flexor digitorum sublimis and becoming tendinous soon after its origin and passing down the arm and beneath the transverse carpal ligament as a slender tendinous cord which inserted in the palm into the tendon of the flexor digitorum profundus passing to the third finger.

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Resumen por el autor, C. Judson Herrick.

Algunos factores en el desarrollo del sistema nervioso
de los anfibios.

El autor considera tres aspectos del problema del origen y desarrollo del sistema nervioso, a saber: 1) Los factores hereditarios de origen muy remoto, tales como el metamerismo primitivo; 2) Los factores hereditarios de origen mas reciente, de significación adaptativa evidente, tales como los patrones de reflejos; 3) El efecto inmediato de la función activa sobre el progreso del desarrollo individual.

En la investigación de los factores segundo y tercero es necesario primeramente descubrir qué representan estas adaptaciones funcionales y como están estructuralmente representadas en el cerebro. La localización anatómica de los sistemas funcionales específicos del cerebro del *Amblystoma* adulto ha sido determinada y este patrón anatómico puede seguirse hacia atrás en la serie embriológica hasta los estados tempranos. La correlación de la estructura de estos estados del desarrollo con los tipos de reacción de especies individuales es al presente objeto de investigaciones. Después se determinen de este modo estos factores funcionales adaptativos en la morfogénesis, el análisis ulterior del proceso del desarrollo mediante métodos experimentales y de otra clase puede llevarse a cabo con mayor facilidad. En el presente trabajo se ha incluido un resumen de los trabajos más recientes sobre el sistema nervioso de *Amblystoma*, así como indicaciones para la investigación cooperativa.

Translation by José F. Nonidez
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SOME FACTORS IN THE DEVELOPMENT OF THE AMPHIBIAN NERVOUS SYSTEM

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Three factors, amongst others, may be recognized in the embryologic development of the brain:

1. Very ancient palingenetic hereditary influences, such as primitive metamerism. These doubtless originally had functional significance, but this is now largely lost and these vestigial features are in most cases masked or suppressed early in developmental history.

2. Obviously adaptive features which are firmly hereditary but of relatively recent (cenogenetic) origin, e.g., reflex patterns and their neuromotor apparatus.

3. The immediate effect of active function upon the progress of individual development—facilitation by use, trophic response of the tissue to excitation, direct action of physiologic gradients of excitation and conduction upon direction and rate of growth (Child, '21), the bioelectric phenomena of excitation and differentiation and their directive influence upon contiguous differentiating neuroblasts (Lillie, '19; Kappers, '17, '21; Bok, '15, '17; Ingvar, '20), hormone action, and probably many others. Some of these are critically discussed by Child ('21).

Students of the embryology of the brain have been inclined to stress the first of these factors, to touch lightly upon the second, and to dismiss the third as irrelevant to their studies. Recent years, however, have seen a notable change brought about largely

¹ This summary has been written up in collaboration with a number of active students of amphibian development, and it seems to us that its publication at this time would serve a useful purpose in promoting more effective integration of efforts now somewhat dispersed among scattered workers by directing attention to certain features of these researches which look toward problems of more general significance.

by improvement in the technical methods of experimental analysis of the problem, and the demand now is for coördinated attack upon the problems of development on all these frontiers.

To learn the rôle of functional adaptations of the second and third types, obviously it is first necessary to determine what these adaptations are. As applied to the development of the central nervous system, this implies a more complete knowledge of the functional localization and functional interrelationships of parts than we possess at present for any animal except man—and even here our ignorance is more extensive than our knowledge. The inconceivable complexity of the human brain is a serious obstacle to such an analysis and, moreover, the mammalian nervous system does not readily submit itself to the methods of experimental embryology.

The amphibian nervous system is free from the two objections just mentioned and in addition it has the further advantage that it begins to function in response to external stimulation at a surprisingly early stage of development. Complex adaptive reflex mechanisms which in the human nervous system attain full structural maturity before they are called upon to act at all can in a series of young amphibian tadpoles be observed in function at progressively advancing stages from the simplest beginnings to very complicated definitive forms, and the structures which are added from stage to stage of the increasingly complex reflex pattern can be identified and correlated with the specific parts which they have to play in the total physiologic complex.

Intensive studies of the development of *Amblystoma*, both observational and experimental, have been in process for a long time. Coghill has observed the earliest reactions of urodele larvae to external stimuli and determined the sequence of progressively more complex behavior patterns. These observations were first made on *Diemyctylus* ('09) and have since been extended to *Amblystoma*. The earliest reactions of these larvae to contacts on the head and trunk are of three types, but all immediately or within a few hours come to a form in which for from 48 to 96 hours the head is regularly moved away from the side touched, an avoiding reaction. This 'early flexure' stage is followed successively by

a series of stages leading up to the 'early swimming' stage. Later experiments on *Amblystoma* have shown that the 'early swimming stage' is followed by 'non-responsive' stages (to tactile stimuli around the mouth), and these by 'feeding' stages.

Coghill and his pupils have in progress an extensive study of the structural changes correlated with this sequence of clearly defined functional stages, some parts of which have been published ('13, '14, '16). The sequence of maturation of the elements of the neuromotor mechanism is found to present a very instructive parallelism with the demonstrated functional sequence and important contributions have been made to the question of the nature of the most primitive reflex mechanisms (cf. Herrick and Coghill, '15).

Mention should be made in this connection of the valuable studies made by Paton ('07) on various species of vertebrates which, though not parallel with Coghill's, were similarly directed, and of the still unpublished work of Dr. H. C. Tracy on the toadfish, *Opsanus*. Both of these include the study of spontaneous movements and also reactions to external stimulation. Tracy has already carried his study of the sequence of the development of the nervous system in correlation with observed behavior to an advanced position. While the details of the development of the reflex patterns of the toadfish are naturally very different from those of amphibians, yet there are some general principles of development common to the two which are very instructive, and the differences between the two species are not less so as illustrative of adaptive changes correlated with the long period during which the toadfish larva is firmly attached in a protected situation.

The present writer has attacked the problem from the opposite side and is engaged upon histological studies of the adult and late larval nervous systems of *Amblystoma* and other urodeles, taking as the point of departure Coghill's earlier ('02) analysis of the functional components of the peripheral nerves. The determination of the exact pathways between the peripheral end-organs and their cerebral centers has permitted an accurate mapping of the primary reflex centers of the brain—tactile, gustatory,

visual, olfactory, etc., and the various motor nuclei. Anatomical continuity between these end-organs and their respective cerebral centers gives a true indication of the functions of the latter. This has been adequately controlled physiologically. By an application of the same principle anatomical analysis of the complex central fiber tracts which connect these primary centers with each other and which connect them with their respective higher correlation centers yields definite information regarding the functions of the higher centers.

The ultimate court of appeal in searching for the precise localization of function in the nervous system is, of course, direct experimentation; but there are many regions of the central nervous system which are as yet inaccessible to such experimental studies, and the anatomical methods just mentioned under proper control are here very serviceable.

The brain of adult *Amblystoma* is very simply organized, with relatively little departure from the form of the early embryonic neural tube, except for the great flexures and the local thickenings of the wall produced by the various correlation centers to which reference has just been made. To these there is added in the forebrain a considerable outpouching or evagination of the entire wall on each side, thus producing two hollow cerebral hemispheres whose pattern is in fundamentals similar to that of the hemispheres of the human brain (cf. Herrick, '21).

Beginning with an analysis of the primary reflex centers of the medulla oblongata and their secondary connections in *Amblystoma* of mid-larval stages (Herrick, '14a), the higher connections of these secondary tracts and their relations to optic and olfactory centers have been determined. These studies are far advanced and, through the united labors of several neurohistologists, we have now a fairly complete knowledge of the functional pattern of the brains of *Amblystoma* and other urodeles. Among the more important contributions to this subject, mention may be made of papers by Kingsbury ('95), Herrick ('10, '14, '17, '21a), Röthig ('11, '11a, '12,), Bindewald ('14), Larsell ('20). The writer also has a considerable mass of observations as yet unpublished.

Notwithstanding the simplicity of external form of these urodele brains, the knowledge of the functional localization derived from studies of the fiber tracts permits the assignment of tolerably precise functional meanings to numerous external landmarks. In short, the reflex patterns as functional entities can be correlated with a mosaic of structural pattern, part of which is externally evident. The neurons of the correlation centers occupy more space than do the related fiber tracts. Accordingly, the location of these centers is indicated by the sculpturing of the external and ventricular surfaces of the brain.

The details of the ventricular structure of the brain of adult *Amblystoma* have not yet been published (for *Necturus*, see Herrick, '17), but these have been carefully charted and their functional connections determined. It is, therefore, possible to define each ventricular eminence and external landmark in terms of functional correlations there effected and to compare these with corresponding regions of the human brain so far as the latter are represented in the Amphibia.

The morphological analysis of the amphibian forebrain published by the writer in 1910 was based largely upon adult material. How far this will stand the test of further embryological and experimental control remains to be determined. It is evident that these conclusions, in so far as they may prove valid, are expressions chiefly, perhaps wholly, of the second and third types of process mentioned at the beginning of this sketch. As was recognized at that time, they are not derived from primitive metamerism, the longitudinal columns of His, or other palingnetic features of that category; but rather they represent later structural modifications superposed upon those ancient patterns.

The next step is to read this mosaic pattern backward into successively younger stages of the development of the brain, identifying each region by its superficial markings or internal fibrous connections or by both of these criteria. This is readily accomplished for each functionally defined area as far backward in the series as its functional fiber-tract connections are demonstrable.

It is found, as the series is followed forward from younger to older stages, that the invasion of a given undifferentiated area by a definite fiber tract arising in a remote part and conducting some specific functional type of nervous impulses is accompanied by a pulse of local differentiation. As the various fiber tracts of the forebrain successively mature and functional connections are made with different regions, there is an immediate structural response in the form of more rapid local proliferation of neuroblasts in the areas newly invaded by the growing fibers. This results first in a thickening of the wall in the differentiating areas on the ventricular side, followed in many cases either by corresponding thickening on the lateral surface or by a local bowing out or buckling of the entire wall producing an evagination.

This localized acceleration of growth can in some cases be correlated with a definite increment, on the side of behavior of the living tadpole, in the complexity of the reflex pattern. The pulse of local differentiation is, therefore, probably very largely of the third physiological type to which reference was made in the beginning, viz., a direct reaction of the embryonic tissue in question to excitation entering from without its own substance, or a true functional response. This excitation is not necessarily a functional response to the stimulation of an end-organ of adult type, but it may be a change in metabolic rate or bioelectric state produced locally by the ingrowth of new axons into indifferent embryonic tissue (cf. the experiments of Ingvar, '20, and the transplantation experiments of Burr, '20).

But it is possible to read this mosaic pattern of regions which in the adult are obviously functionally defined back to still younger stages in some cases, that is, these regions present recognizable morphological criteria at stages antecedent to the appearance of functional fiber-tract connections. Regions which in the adult are of high functional value, in prefuctional stages may exhibit an acceleration of growth resulting in various local thickenings and dilatations of the neural tube and the great flexures. This would seem to imply hereditary factors of the type characterized by Cope ('87, p. 126) as heterochronous accelerated development, to wit, the appearance of adaptive struc-

tures at a date earlier in the ontogeny than would be consonant with an exact recapitulation of the phylogeny. How far this type of differentiation is due to the actual inheritance of morphological pattern such that particular parts of the neural tube tend to unfold in a predetermined way through the action of resident forces, and how far this sequence of changes in a particular region is due to the present influence of morphogenetic factors acting upon it from its intraorganic environment, such as Child's gradients, hormones, etc., is an approachable problem.

An important first step would seem to be the determination of the exact functional pattern which in the final stage—the adult brain—is reflected in the structural mosaic of the definitive neural tube. A second step carries this mosaic pattern back to the earlier stages of the ontogeny as far as the functional factors of the adult type can be shown to be operative, that is, to the first appearance of the several fiber-tract connections of known functional significance.

After the morphogenetic influence of these factors is determined, the residual factors must be further analyzed, and here a variety of methods are available. Some of these methods are purely observational, some are experimental.

The embryology of the Amphibia has been much studied. The only detailed account of the early development of the nervous system of *Amblystoma* is that of Griggs ('10), though there are several good accounts of the formation of the neural tube and the earlier phases of its differentiation of other urodeles. No description of the later stages of the brain of *Amblystoma* has been published.

Landacre is investigating the cranial ganglia of urodeles and has published ('21) an important paper giving the history of the neural crest. He describes extensive contributions of cells from this and other ectodermal sources to mesodermic structures (formation of mesectoderm), and follows the history of some of these cells through to their ultimate differentiation into head cartilages. This commingling of cells of the same origin as those of the brain with the cells of entodermal mesenchyme in the formation of non-nervous organs of the head may play some rôle as yet

undetermined in the equilibrated systems of growth. The relations of the definitive cranial ganglia to the neural crest and of both of these to the neural tube on one hand, and to the general ectoderm, on the other hand, have been investigated by Landacre in a number of vertebrates, and further studies of these questions and of the formation of mesectoderm in Amphibia are in process. Coghill has published ('16) graphic reconstructions of the functional composition of the cranial ganglia and related sensory centers of the medulla oblongata of *Amblystoma* in four of his functionally defined stages.

The further prosecution of these embryological studies will contribute much of value in the analysis of the morphogenetic factors operative in the development of the nervous system of *Amblystoma*. We wish to know what was the primitive segmentation of the urodele head and the fate of these segments in the later development of the nervous system, what are the sources from which the various parts of the central and peripheral nervous system have drawn their building material (these apparently differ in closely allied species); what (if any) are the inherited potencies of these various kinds of material; to what extent and in what ways do excitations acting directly upon them shape the course of their development; and the evidence (if any) of the presence of inherited patterns of adaptive (cenogenetic) type in this development.

Evidently observational methods alone are incompetent to answer all of these questions, but observation must furnish the sound basis upon which crucial experimental tests can be devised. And it is indispensable that the observational studies and the experimental program be kept in the closest possible articulation. Coghill, for instance, is engaged upon a correlation of the growth rhythms of the central nervous system (as measured by the number and distribution of mitotic figures at successive stages of known physiological type) with those of various non-nervous organ systems. This may shed light upon the nature of the physiological equilibrium in the organism as a whole during the march of these events, and it would not be at all surprising if these observations would correlate in a fruitful way with studies on the morphogenetic influence of the ductless glands.

Experimental investigation of the interrelationships of the endocrine organs during development has already brought to light some surprising facts. As illustrations of these, mention may be made of the studies upon the Amphibian hypophysis of Allen ('16, '20) and P. E. Smith ('20). These exhibit the influence of an organ upon remote parts of the body through the agency of transported materials.

It has long been supposed that contiguous parts may exert a chemotactic or other influence upon the development of the nervous system, and the recent studies of the bioelectric phenomena of metabolism, and especially of excitation and conduction, to which reference has already been made, have suggested a possible mechanism for this type of reaction of the tissues. The investigation in the Amphibia of the physiological gradients to which Child has devoted so much attention has been begun by Bellamy ('19). He has studied the effects of various toxic and depressing agents upon the gradients in physiological activity along the axes of the embryo and the rôle of the normal physiological gradients as morphogenetic factors. Publication of further results of these experiments is promised, and it may confidently be expected that additional data of far-reaching importance in the analysis of the functional components in the complex history of the development of the nervous system will be brought out.

From the dawn of experimental embryology until now the Amphibia have presented most favorable materials for experiments in this field. Limitations of space here forbid reference to even the most important of these investigations, but it is generally recognized that this avenue offers a very direct approach to the problems centering about the relations of developmental factors intrinsic to an organ or tissue and those which are the expressions of extrinsic agents. In this country *Amblystoma* is a more satisfactory subject for many of these lines of inquiry than any other type. The genus is widely distributed, the eggs are easily collected and reared, and the larvae are hardy and favorable for operative work. The activities of Harrison's laboratories in recent years have given evidence of the peculiar fitness of this material for many lines of embryological study.

Burr in three recent studies ('16, '16 a, '20) has opened a fruitful line of investigation by a direct frontal attack upon the question of the relation between intrinsic and extrinsic factors in the morphogenesis of the cerebral hemispheres of *Amblystoma*. By an ingeniously planned series of experiments he has shown that the hemisphere develops under the influence of excitations entering at opposite ends, from the olfactory organ and the thalamus, respectively. The destruction of the nasal organ in prefunctional stages results in the failure of the rostral end of the hemisphere to complete its differentiation. The effect of cutting off all nervous impulses coming into the hemisphere from the thalamus was determined by transplanting the hemisphere, before the ingrowth of such fibers, into the skin of the side of the body. The olfactory placode was transplanted with the hemisphere and made connection with the brain in the normal way. The hemisphere developed to nearly normal size, but the parts normally directly connected with the diencephalon were retarded in development. No part was totally atrophied, in conformity with the well-known fact that practically all parts of this hemisphere receive fibers from the olfactory bulb, which was well developed. In one series of experiments the olfactory placode was transplanted to a superficial position so that (presumably) it was capable, in later stages, of normal peripheral stimulation; in another series the placode was buried beneath the skin so as to preclude stimulation from the exterior. The related transplanted hemispheres developed equally in the two cases, showing that the stimulus to differentiation of the olfactory centers is provided by the ingrowth of the olfactory fibers, even though these are never normally excited. It would be interesting to learn the effect of carrying the experiment further and transplanting the cerebral hemisphere alone without the olfactory placode, thus isolating it completely from any form of nervous excitations. This would show whether the primitive hemisphere vesicle has any capacity whatever for intrinsic differentiation beyond the stage normally reached when nerve fibers first penetrate it from adjacent parts.

In another series of experiments it was shown that extirpation of the hemispheres in prefunctional stages is followed by very

little regeneration in case the olfactory placode is also removed; but if the latter is left in place the hemisphere does regenerate to normal form under the influence of the ingrowing olfactory fibers.

Such experiments can be indefinitely multiplied, and it is very desirable that this should be done, and also that after such operations the larvae should be reared (in so far as they are viable) to a sufficiently advanced stage of functional development as to permit of precise determination of the regulatory changes in the arrangement of the fiber tracts and correlation centers by comparison with normal larvae of corresponding ages. This can be accomplished with considerable completeness by the use of the silver-impregnation methods of Cajal and Bielschowsky. Normal specimens of various ages up to adult are already available in the collections of Coghill, McKibben, Watkins, Burr, and others, and these are now in process of intensive study.

It is no accident that these and many other energetic workers in so diverse fields have converged their activities upon the development of the Amphibia. This material is very favorable for attack upon the most fundamental problems of growth and differentiation. In the cerebral hemispheres we find here the same morphological type as in mammals, but reduced to lowest terms, and the morphogenetic factors in the two cases doubtless have much in common. Studies on the early development of the human cerebral hemispheres made by Dr. Marion Hines Loeb and others in the laboratories of the University of Chicago have brought to light unexpected similarities with those of lower vertebrates, features which have in the past been overlooked just because the simpler paradigm was not taken into the reckoning.

The various researches to which reference has been made here and others on kindred topics which might have been mentioned have, for the most part, been independently planned and executed. They represent no formal collaboration, no elaborate machinery of organization. Men of diverse training and aptitudes have studied problems as they were presented, and their natural interests have drawn them together from different quarters. In the aggregate these investigations form an impressive

exhibit of successful accomplishment and still greater promise for the future.

As for this future, the best results will probably continue to follow from the unrestrained initiative of the individual workers. But, in view of the fact that this entire body of research does have so obvious an application to fundamental problems, and that the concentration of so diverse inquiries upon a single species gives broader promise than could be expected from any single line of investigation, it is probably expedient for those now working on *Amblystoma* to seek somewhat closer contacts with each other and more consciously so to direct their programs of research as to make the largest possible use of data supplied by their co-workers.

In particular, the experimental workers, who may not be in a position to carry to completion the very desirable (but very laborious) morphological studies necessary for the broadest interpretation of their results, may find it advantageous at times to seek conference on these questions. I refer especially to matters of internal structure, courses of fiber tracts, functional connections of correlation centers, etc., at definite ages, regarding which there is a large body of ascertained fact, much of which is as yet unpublished.

One of the first desiderata is an authoritative record of the chief characteristics of the nervous system at successive stages of development, arranged preferably by stages, as yet unpublished, as defined by Harrison, and these in correlation with known stages of physiological development—in short, a series of normal tables of the nervous system, based on the sequence of both structural and functional development. This enterprise it is hoped will soon be undertaken in the Yale laboratories under the direction of Doctor Burr, and will serve as a useful norm or datum of reference for comparison with the quantitative studies of growth of mammalian types now so actively prosecuted in several American laboratories.

An account of the plastic changes in the external form should follow, with pictures of the stages from models. The description of these form changes is, however, largely dependent for its value

upon the identification of the regions in correlation with adult structure and functional localization at successive ages. The data for such a correlation are still far from complete, but are accumulating, and it is hoped that the time is not far distant when such a description can be written, with more or less of correlation of changes in external form with corresponding changes in behavior pattern and in histological differentiation internally. More detailed studies of the development of reflex patterns from early larval to adult stages are necessary for the consummation of the program.

March 2, 1922

ADDENDUM

At the time when these proof sheets pass to the press (April 11, 1922) it can be stated that the studies referred to in the last sentence above are in process. Under a research program organized jointly by the University of Kansas and the University of Chicago, Doctor Coghill and Mr. Watkins have this season already studied intensively the early development of the reflex pattern in upwards of 100 individual larvae of *Amblystoma* and the work is now continuing to include still other series of specimens. Many hundreds of specimens of tested physiological age have been fixed for future histological study.

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Resumen por el autor, Austin T. Moore.

**Una conexión anómala de los músculos piriforme y biceps
del fémur.**

Durante una disección de un varón negro bien desarrollado, de unos treinta y siete años de edad, el autor encontró un músculo distinto biventral que se extendía desde la pelvis llegando hasta el biceps femoral, en la unión de sus cabezas larga y corta. El músculo se originaba en forma de un tracto separado de las fibras antero-inferiores del músculo piriforme, pasando a través del gran foramen ciático y procediendo distalmente y lateralmente sobre la superficie posterior de la tibia por debajo del glúteo máximo. Un poco antes de alcanzar el borde inferior de este musculo se convertía en tendinoso, continuando de este modo hasta el nivel del origen superior de la cabeza corta del beceps. En este punto el musculo descrito volvía a transformarse en carnoso terminando el en biceps femoral, en la unión de sus cabezas corta y larga.

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AN ANOMALOUS CONNECTION OF THE PIRIFORMIS AND BICEPS FEMORIS MUSCLES

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ONE FIGURE

During the course of dissecting a well-developed negro, apparently between thirty-five and forty years of age, there was found a distinct double-bellied muscular anomaly in association with the piriformis and biceps femoris muscles, extending from the origin of the piriformis to the junction of the long head of the biceps with its short head. No other muscular abnormalities were observed.

The muscle arose as a detached slip of the lower anterior fibers of the piriformis, and lay on the anterior surface of this muscle near its lower border in the first part of its course. Passing out of the greater sciatic foramen, it proceeded distally and laterally in the posterior aspect of the thigh under cover of the gluteus maximus. Just before reaching the lower border of this muscle it became tendinous. This tendon, of approximately 2 mm. in diameter, continued underneath the long head of the biceps till it reached the level of the upper origin of the short head of the biceps. Here the muscle again became fleshy and continued to the junction of the long and short heads of the biceps, terminating in their common tendon of insertion into the tibia and fibula. The general appearances and relations are diagrammatically shown in the accompanying figure.

The superior belly derived its nerve supply from a small branch of the great sciatic nerve. The inferior was supplied by two small twigs from the branch of the nerve to the hamstring muscles that supplied the short head of the biceps.

The blood supply was derived from two sources. A branch of the inferior gluteal artery supplied the superior belly, while the inferior belly was supplied by twigs from the third and fourth perforating branches of the profunda femoris artery.

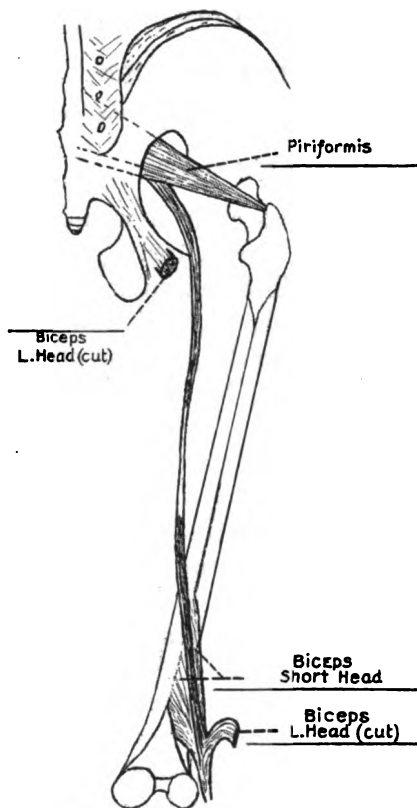


Fig. 1 Sketch of a double-bellied anomalous muscle extending from the piriformis to the junction of the long and short heads of the biceps. From an adult negro.

In the literature accessible to me, no anomaly identical with this has been found, although several observers have reported muscular fascicles, associated with the biceps, with which the muscle herein reported has some common resemblances.

Wood (1) reports a muscle arising from the under surface of the gluteus maximus and inserted into the long head of the biceps.

Halliburton (2) describes a muscle having a contiguous origin with the long head of the biceps, but inserted into the gastrocnemius.

Testut (3) reports a double origin of the biceps, the abnormal head arising from the coccyx.

LeDouble (4) reports a muscle having a common origin with the biceps, but inserted into the tendo calcaneus. He also states that Macalister has reported a muscle arising from the outside of the sacrum and that Soemmering has reported one arising from the pelvis, but terminating at the ischium.

LeDouble, from consideration of the abnormalities of the biceps observed by himself and also from the reports of others, divides them into two classes: First, those having a pelvic origin terminate in the long portion of the biceps; second, those having an origin in the posterior region of the thigh terminate in the short portion of the biceps. It is seen that the muscle here reported falls in neither of these classes.

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Resumen por el autor, O. Ishii.

Observaciones sobre el ciclo sexual de la rata albina.

En el presente trabajo se discuten los siguientes puntos: 1) ¿Sigue la preñez a la primera copulación de la rata? 2) Duración del periodo de gestación. 3) Influencia de la alimentación sobre el número de individuos de la cría. 4) Condición de la rata en vías de crecimiento después del nacimiento. 5) La época del primer estro general en la rata. 6) Signos del primer estro general. 7) Distinción entre el estro general y el periodo de ardor sexual propiamente dicho. El autor ha encontrado que el método de los frotos no permite una distinción entre estas dos condiciones. 8) Duración, época de la aparición y signos del periodo de ardor sexual propiamente dicho en la rata. 9) Periodo diéstrico. 10) ¿Ejerce la copulación estéril influencia sobre el ciclo sexual de la rata?

Translation by José F. Nonides
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OBSERVATIONS ON THE SEXUAL CYCLE OF THE WHITE RAT

O. ISHII

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1. Normal pregnancy does not usually result from the first copulation, but only when copulation has taken place more than once does the female become pregnant. For this purpose it is, furthermore, necessary that copulation with a healthy male take place at the actual period of heat of the female rat. On very rare occasions, however, pregnancy may result from a single copulation. The same I found also to hold good in the case of guinea-pigs.

2. In the majority of cases the duration of the gestation period of the rat is $21\frac{1}{2}$ to $22\frac{1}{2}$ days. My observations on this point confirm those of Stotsenburg (4). However, in some exceptional cases I have found the period of pregnancy to last 23 days.

3. To determine the influence of nourishment on the size of the litter, I observed two sets of ordinary stock rats. a) In the first set they were fed grain, green vegetables, and milk once a day; b) in the second set they were fed table scraps three times a day. This material was fresh and in good condition every time. In both sets special care was taken to keep the cages dry, since wet cages disturb the health of the animals. In the first set the number in the litter averaged from six to nine and sometimes reached ten or eleven; in the second set the average was greater, namely, from nine to twelve and sometimes more. Stotsenburg (4) also found that feeding with table scraps causes the size of the litter to be larger than a diet of bread and milk.

4. The weight of the young rat at birth was on the average from 4 to 5 grams; this agrees with the statements of various authors. In addition, I have observed that the hair begins to grow about seven to eight days after birth, when it has the

appearance of very fine fur visible to the naked eye. In healthy rats the eyes open about on the fourteenth or fifteenth day.

5. The time of the first general oestrus in the rat. The statements of various authors vary as to the age at which the first general oestrus occurs in the rat.¹ Thus Long and Evans (3) state that on the average it takes place at the age of 70 to 90 days and in some cases the date may vary between 45 and 120 days, while Donaldson reports that breeding begins at the age of about three months. Recently H. M. Evans and K. L. Bishop stated that the first oestrus begins on the average at the age of 47 days and that the dioestrous period lasts on the average of 5.4 days. This holds good if the animals are fed with a standard diet consisting of whole wheat, whole-milk powder, casein, salts, and 5 per cent butterfat. According to my statistics, in rats which are fed on table scraps the opening of the vagina or the first menstruation occurs in normal animals weighing from 60 to 80 grams at an age of 32 to 40 days; sometimes they may, however, be as old as 45 days.

6. Signs of the first general oestrus. Up to the time of the first general oestrous period the vaginal lips are closed with a thin membrane. Gradually the membrane begins to rupture. The maximum enlargement in the opening is reached five to seven days after the onset of the general oestrus. During this period there is no appreciable amount of moist secretion visible at the vaginal orifice; only a dry material is found. This is followed by a stage in which the secretion becomes more copious and serous or watery in character as it is found at the ordinary oestrous period. Now, the vaginal lips are slightly swollen and glistening. In some cases the rat comes into actual heat in the first general oestrous period, but often copulation does not take place at that time. In other words, the animal has not yet reached the condition of heat proper. After the onset of the second general oestrous period real heat occurs in every rat. According to my previous

¹ We shall distinguish between general oestrus and heat proper. By the former we understand the whole period during which an increased secretion is visible at the vaginal orifice, while the latter is only the period in which the female is ready for copulation. The second period forms a part of the first one.

observations, conditions are analogous in the guinea-pig. Here also the first general oestrus is prolonged.

7. Distinction between heat and the general oestrus in the rat. Some authors do not distinguish between the period of general oestrus, which is characterized by secretion, and the heat proper. When the rat comes into heat, she becomes somewhat more playful and holds up her tail and the external portion of the vagina. At this time she is ready for copulation, if a male rat approaches her and attaches himself to her back. Whenever she is not ready for copulation, the real period of heat is not present. The heat represents one period in the general oestrous period. Long and Evans have stated that they can determine the heat period by means of the vaginal-smear method of Stockard and Papanicolaou (5). Contrary to this conclusion, we do not find that the smear method enables us to distinguish between heat proper and the general oestrous period.

8. The heat period proper in the rat. This period has an average uninterrupted duration of from four to six hours. During the greater part of the period there is a secretion visible on the external vagina. Towards the end of this heat period, however, the secretion is either lacking altogether or its amount is very much decreased. I have found this to hold equally good in the case of the guinea-pig. In one exceptional case I have, however, noticed that the heat period proper lasted continuously for eight hours. Another important point is that in most cases the rat enters into the heat period proper usually about midnight, or after 9 o'clock; only in rare cases does this period take place in the daytime.

Duration of the dioestrous period in the rat

NUMBER OF ANIMAL	AGE AT TIME FIRST OESTRUS	1st	2ND	3RD	4TH	5TH	6TH	7TH	8TH	9TH	10TH	11TH	12TH	13TH	14TH
	<i>days</i>														
1	33	11	18	5	5	7	3	8	5	3	6	7	4	5	8
2	35	4	5	13	10	5	9	5	20	3	4	2	4	2	4
3	43	5	5	12	6	9	3	5	4	3	2	5	4	3	6
4	45	4	4	12	10	15	4	9	5	3	5	11	2	7	5

The figures signify the number of days between two successive oestrous periods.

9. Dioestrous period of the rat. According to Long and Evans (3), the rat shows a very peculiar dioestrous period. The length of this period varies in each individual case. We likewise obtained a marked variation in the length of the dioestrous period.

According to the data of this table, the longest duration of the dioestrous period was twenty days; the shortest two days; furthermore, in each individual the duration varies in different periods. There is some reason for assuming that in case the dioestrous period lasts only two days heat proper did not develop inasmuch as the female did not accept the male, although vaginal secretion was present. True heat was, however, found in those rats in which the dioestrous period lasted three or more days.

10. Does sterile copulation exert an influence on the sexual cycle in the rat? According to Long and Evans (3), a sterile copulation in the rat leads to a lengthening in the subsequent dioestrous periods. Some years ago I had made a similar suggestion; however, actual observation of guinea-pigs, in which the animals after copulation apparently did not develop pregnancy, did not reveal any difference in the duration of the sexual cycle between these and normal animals which had not copulated. My recent observations show that the same holds good in the case of the rat. Here also sterile copulation has no influence on the sexual cycle.

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Resumen por el autor, Howard H. Bell

Páncreas horizontal y vertical en asociación con otras anomalías del desarrollo.

El primer ejemplar descrito posee un proceso horizontal de 51 mm. de longitud, semejante al páncreas normal, un proceso vertical de 28 mm. de longitud, que pasa hacia abajo deslizándose sobre la superficie mesial del duodeno, y un proceso anular alrededor de este último; todos estos procesos se reúnen en el sitio ocupado por la cabeza del páncreas normal. El proceso anular presenta un conducto separado. El tabique interventricular del corazón es defectuoso por debajo de la parte membranosa. El agujero oval y el conducto de Botal son permeables. En el lado derecho existe una hernia umbilical y otra inguinal. El divertículo de Meckel persiste.

En el segundo ejemplar ha hallado el autor: Un divertículo de la pared posterior del estómago, situado debajo del orificio esofágico y unido con las meninges a través de las hendiduras vertebrales. El intestino delgado abandona la pared posterior del estómago en la línea media, debajo de este divertículo. En el extremo pilórico del estómago existe otro divertículo, origen del hígado y páncreas. El páncreas posee un proceso horizontal de 65 mm. de longitud, el cual cruza la pared anterior del estómago, y un proceso vertical de 34 mm. que pasa hacia abajo. El primero posee un conducto independiente que se abre en el divertículo a una distancia de 5 mm. del otro orificio. Resumen de las anomalías asociadas: Espina bífida posterior con mielocistomeningocele; espina bífida anterior; puente intraespinal, médula oblongada y cerebelo rudimentario; ausencia del tentorio cerebelar; ausencia de la isla de Reil; ausencia de glándula pineal, acueducto de Silvio y cuerpos cuadrigéminos; anomalía en la circulación cardíaca, hígado, estómago y páncreas; defectos en el lado izquierdo del diafragma; ausencia del omento mayor, divertículo de Meckel bifurcado; disposición anormal de los intestinos grueso y delgado; testículos no descendidos; talipes varus.

Translation by José F. Nonides
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HORIZONTAL AND VERTICAL PANCREAS, IN ASSOCIATION WITH OTHER DEVELOPMENTAL ABNORMALITIES

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TWO FIGURES

This type of abnormality in the development of the pancreas was described by Carnot.¹ The pancreas in his case possessed a head, a horizontal process 10 cm. long, resembling the body and tail of the normal pancreas, and a vertical process 12 cm. long extending downward from the head along the duodenum. Neve² mentioned extra tail lobes as an instance of reversion to a lower type. I have failed to find further reference in the literature to pancreas with horizontal and vertical processes, yet I have found two instances of this anomaly.

The first instance occurred in a well-nourished white male child, four months old. The cause of death was bronchopneumonia and extensive atelectasis.

The pancreas completely encircled the second part of the duodenum and possessed a horizontal and a vertical process. The band of pancreatic tissue encircling the duodenum was 10 mm. wide anteriorly, and 6 mm. wide posteriorly. The horizontal process resembled the normal pancreas. It measured 51 mm. long and 11 mm. in the other dimensions. Along the upper border near the duodenum was a rounded enlargement 11 mm. across. The vertical process descended along the mesial surface of the second part of the duodenum and passed anterior to the transverse part. This process measured 28 mm. long and 9 mm. in the other dimensions. The two processes and the annular part joined at the site occupied by the head of the nor-

¹ Carnot. *Maladies des glands salivaires*. Paris, 1908.

² Neve. *The Indian Medical Record*, 1892, vol. 3, no. 3.

mal pancreas. The annular part encircled the duodenum from behind forward and was in apposition with pancreatic tissue anteriorly, but not continuous with it. The duodenum was slightly constricted at this point.

The common bile duct opened into the duodenum with the pancreatic duct from the horizontal and vertical processes. The annular part possessed an individual duct opening into the duodenum slightly above and posterior to the ampulla of Vater.

Other developmental abnormalities were present. The interventricular septum of the heart was defective below the membranous part. This defect measured 21 mm. vertically, and 11 mm. horizontally. The foramen ovale and ductus Botalli were pervious, but the openings were very small. There was a slight umbilical hernia and a small inguinal hernia on the right side. Meckel's diverticulum persisted and measured 5 cm. long.

The second anomaly occurred in association with anterior spina bifida and other abnormalities which will be described elsewhere.

The infant was still-born at term. The stomach was greatly dilated. The small intestine joined the posterior wall of the stomach in the midline of the body. It opened into the cavity of the stomach by a slit-like orifice guarded by a valve-like fold. From the point where the intestine met the stomach to the site of its gastric orifice, it lies beneath the gastric peritoneum (See Fig. 2). The gastric orifice of the intestine was 5.5 cm. from the pyloric end of the stomach. The pyloric end of the stomach had the form of a blind diverticulum into which the common bile duct opened. The horizontal and vertical pancreatic processes met upon this diverticulum. The diverticulum was about 1 cm. wide and 1.5 cm. long and ended in a blind rounded extremity.

The pancreas possessed a horizontal and a vertical process. The horizontal process extended across the anterior wall of the stomach and was loosely attached to it. It measured 65 mm. long, 9 mm. wide, and 4 mm. thick. The vertical process extended downward. Its lower extremity was slightly enlarged and was turned abruptly backwards. The upper part of this process measured 34 mm. long, 9 mm. wide and 4 mm. antero-

posteriorly. The lower part, which was enlarged and turned backwards, measured 12 mm. anteroposteriorly, 14 mm. vertically, and 5 mm. transversely. The horizontal and vertical processes were contiguous over the summit of the diverticulum.

There were two papillae with openings into the diverticulum, situated about 5 mm. apart. The duct from the vertical process led in conjunction with the common bile duct into the end of the diverticulum. The duct from the horizontal process opened into the superior wall of the diverticulum.

The relation of the pancreatic processes and associated organs to the stomach is shown in fig. 1.

Many abnormalities were associated with the second specimen. The liver was abnormal in shape. There was a funnel-shaped diverticulum from the posterior wall of the stomach below and posterior to the oesophageal opening, which was attached to the meninges through the anterior spina bifida. The relation of this opening to the stomach is shown in fig. 2.

A summary of associated abnormalities is as follows:

- Posterior spina bifida with myelocystomeningocele
- Anterior spina bifida
- Intraspinal pons, medulla and rudimentary cerebellum
- Absence of tentorium cerebelli
- Accessory superior longitudinal fissure in right hemisphere
- Absence of islands of Reil
- Absence of pineal body, aqueduct of Sylvius and corpora quadrigemina
- Abnormality of heart
- Defect in diaphragm on left side
- Abnormality of liver and stomach
- Absence of greater omentum
- Bifurcated Meckel's diverticulum
- Abnormal arrangement of small and large intestines
- Undescended testicles
- Talipes varus.

Two related cases described by Graefe and Vesalius were mentioned by Mondière.³ The one described by Graefe pos-

³ Mondière. *Archiv. gén. de Méd.*, 1836, 2d ser., T. 11.

sessed three pancreatic ducts, one of which opened into the stomach. Richeraud stated in his physiology that Vesalius described a case in which the ductus choledochus emptied into the stomach.

Aberrant pancreatic tissue has occurred in the wall of the stomach in several instances.⁴

The human pancreas develops from one posterior and one anterior bud; occasionally there are two anterior buds which soon fuse to form one. The posterior and anterior processes grow together to form the mature pancreas.⁵

The shape of the pancreas varies in different species. The pancreas of the ox and sheep is irregularly quadrilateral in form.⁶ The pancreas of the horse is very irregular, although triangular in outline. The pancreas of the pig is elongated and situated transversely. The right portion has two lobes; the posterior lobe bends around the great mesenteric artery and the portal vein; the anterior one is pointed, extends downward and forward in the median plane and is attached in the portal fissure and to the duodenum. The left portion is prismatic and rests mainly on the left sac of the stomach, its left extremity being included between the left kidney and the dorsal end of the spleen. The pancreas of the dog is V-shaped, consisting of two long, narrow branches which meet at an acute angle. The right branch extends along the duodenum. The left branch is attached to the peritoneal surface of the stomach. In the cat the pancreas has two processes; one process extends along the duodenum and the other process extends along the stomach. The two processes are nearly at right angles to one another.⁷

⁴ Opie, E. L. *Disease of the pancreas*. 1910. J. B. Lippincott Co., Philadelphia.

⁵ Keith. *Human Embryology*. 1913. Edward Arnold, London.

⁶ Sisson. *Veterinary anatomy*. 1910. W. B. Saunders Company, Philadelphia.

⁷ Reighard and Jennings. *Anatomy of the cat*. 1910. Henry Holt & Co., New York.

The first specimen resembles the pancreas of the dog and cat in that it has a horizontal and a vertical process, although it has in addition an annular process. The position of the pancreatic ducts in this specimen would indicate that the annular part developed from posterior budding and the horizontal and vertical processes from anterior budding.

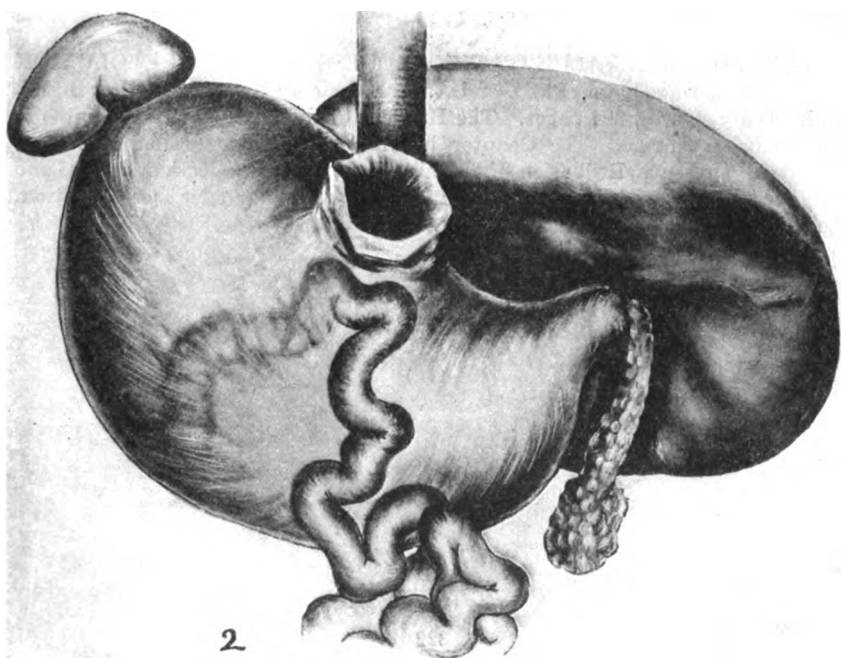
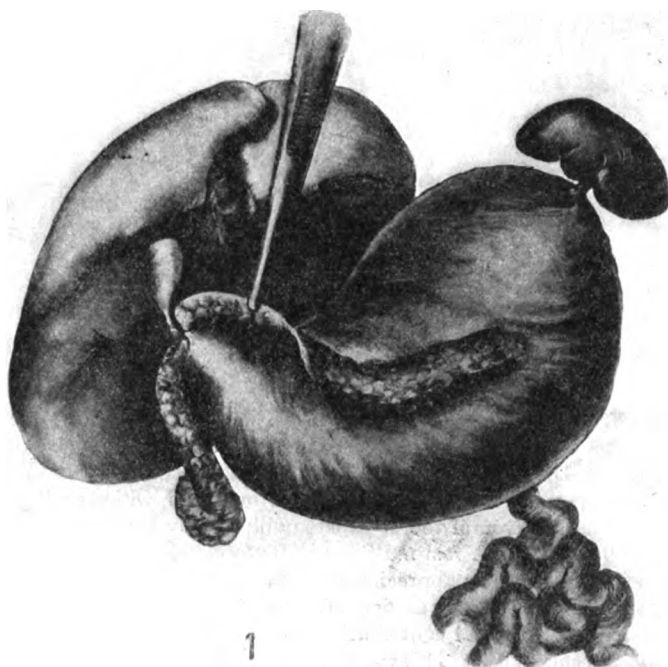
The second specimen was associated with many unusual abnormalities. The horizontal and vertical processes were in apposition on the summit of the gastric diverticulum, although no fusion had taken place.

PLATE 1

EXPLANATION OF FIGURES

1 Drawing of anterior view of liver, stomach, pancreas and spleen. The liver is raised, and the right end of the horizontal pancreas is elevated with forceps, to show the relation of the liver, the horizontal and vertical pancreas to the diverticulum of the stomach.

2 Drawing of posterior view of organs. The liver is tilted forward. Below and posterior to the oesophagus is shown the diverticulum which was attached to the cleft vertebrae. Below this diverticulum the small intestine passes obliquely through the wall of the stomach and opens into it.



BOOKS RECEIVED

(Continued from first page)

THE RANSOHOFF MEMORIAL VOLUME. A Collection of Papers representing Original Contributions to the Art and Science of Medicine by Colleagues and Students of Dr. Joseph Ransohoff, M.D., F.R.C.S. (Eng.), F.A.C.S., LL.D. 574 pages, illustrated, containing 57 papers. Cincinnati, Ohio, S. Rosenthal & Co. 1921. A list is given of the 44 papers published by Dr. Ransohoff between the years 1879 and 1920. *From the Editors' Preface.* In an effort to express to Dr. Joseph Ransohoff their appreciation of his place in the science and art of Medicine, a group of his former students determined to issue a volume containing papers consisting of original contributions to the advancement of Medicine by his students and colleagues. This was in June, 1920. The death of Dr. Ransohoff prevented the presentation of this book to him personally, but the publication was continued as a Memorial Volume.

THE RELATIVE VALUE OF THE PROCESSES CAUSING EVOLUTION by Arend L. Hagedoorn, Ph.D. and A. C. Hagedoorn—Vorstheuvcl La Brand, with twenty figures, 294 pages. The Hague, Martinus Nijhoff, 1921, printed in the English language. The Chapter headings are: Introduction, Heredity, Variation, Crossing, Reduction of Variability, Mutation, Selection, Species and Varieties, The Law of Johannen, Evolution in Nature and under Domestication, The Status of Man.

A STUDY OF THE SUPERFICIAL VEINS IN THE SUPERIOR EXTREMITY OF LIVE JAPANESE

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TEN FIGURES

A study of the superficial veins in the superior extremity of live subjects is important for intravenous injection in practice. With this object, I have examined the superficial veins in the superior extremity of live Japanese. A similar investigation we have already seen in the paper of Richard J. A. Berry and his student, H. A. S. Newton.¹ But this study of Japanese is not without interest for the anatomy of the race. I shall be very happy if this study proves of service to the angiology in Japanese, which is now in the hands of my teacher, Prof. Dr. B. Adachi (Kyoto).

The subjects of my study were one hundred men. Eighty of these were students of the Medical Department of the Keio University and twenty were my friends, for which I express my sincere gratitude for their kindness. The procedure adopted, as Berry and Newton used, was the usual one of keeping the limbs in a dependent contraction and then banding the distended veins.

A. The v. cephalica (B.N.A.)

In the paper of Berry and Newton we seen the v. cephalica arising as a direct communication of the radial end of the arcus venosus dorsalis manus. But in my case I have found it arising from the v. metacarpea dorsalis I by the rete venosum dorsale manus. Of the proximal course of this vein occur three types.

¹ Richard J. A. Berry and H. A. S. Newton. A study of the superficial veins of the superior extremity in 300 living subjects. *Anat. Anz.*, Bd. 33, 1908.

Type 1. The *v. cephalica* curves round the radial border of the forearm proximal to the *processus styloideus* of the radius on the volar surface. Here the vein continues to pass proximally and slightly medially to the bend of the elbow, where it gives off the *v. mediana cubiti*. Continuing its proximal course, the *v. cephalica* runs in the *sulcus bicipitalis lateralis* and then in the *trigonum deltoideopectorale* to its termination. This first type in my description has no accessory cephalic vein and no 'Inselbildung.' I have found this type in 19 per cent in my cases (21 per cent on the right, 17 per cent on the left).

Type 2. The *v. cephalica* has a so-called 'Inselbildung' in its course. Berry and Newton did not describe such a type in their paper, but they described it in the *v. cephalica accessoria* which originated from the *v. cephalica* itself. They found this type in 16 per cent of cases in Europeans. I have found this in 27 per cent in Japanese (31 per cent on the right, 23 per cent on the left).

Type 3. The *v. cephalica* with an accessory vein (the *v. cephalica accessoria B.N.A.*). This accessory vein is a second longitudinal vessel situated laterally on the forearm, which opens into the main cephalic vein. In this case the main cephalic vein lies somewhat more medially than in the case without this vein. In Europeans Berry and Newton found this in no less than 80 per cent, but in Japanese I have found only 43 per cent (47 per cent on the right, 39 per cent on the left).

The termination of the *v. cephalica* was constant. Cases where the *v. cephalica* turned medially across the distal third part of the arm to terminate in the *v. basilica*, as described in the paper of Berry and Newton, were not found in my subjects. But cases in which the branchial portion of the cephalic vein was very weak were found in 4.5 per cent in my case (2 per cent on the right, 7 per cent on the left). In every instance Berry and Newton found the cephalic vein arising as a direct continuation of the radial end of the *arcus venosus dorsalis manus*. In my case it was abnormal in 6 per cent (5 per cent on the right, 7 per cent on the left). The cephalic vein arose from the ulnar end of the *arcus venosus dorsalis manus* or the *rete venosum dorsale manus* and the radial end of the *arcus* or the *rete* passed proximally to

the forearm and terminated in the v. basilica in the elbow flexure. In these cases the v. mediana antibrachii terminated in this abnormal vein. The cephalic vein received a large oblique vein (v. obliqua) from the ulnar end of the arcus venosus dorsalis manus in 41 per cent of my cases. The connection between the v. cephalica and the deep brachial vein in the elbow flexure was found relatively rare in live subjects. I have found this only in five cases (two cases on the right, three on the left) in 200 subjects. In this case the v. cephalica usually did not give off the v. mediana cubiti. The v. mediana cubiti was absent also in 14.5 per cent (10 per cent on the right, 19 per cent on the left) of my cases. The abnormal reduplication of the cephalic vein was found only in one case (no. 26, student twenty-two years) (see Abnormalities).

B. The v. basilica (B.N.A.)

The course of this vein is remarkably constant. As regards the normal origin of this vein, I have observed that it arose from the v. metacarpea IV or the ulnar end of the arcus venosus dorsalis manus. In 44 per cent (44 per cent on the right, 44 per cent on the left) the v. mediana antibrachii terminated in this v. basilica, which is in agreement with the figures of Berry and Newton (43 per cent in their case). The termination of the v. basilica in my subjects was constant (i.e., perforated the fascia brachii in the sulcus bicipitalis medialis). The type mentioned by Carle,² where this vein terminated in the v. axillaris, was not found in my cases. Very rare variation of this vein is of some interest in the making of 'Inseln' in its course. I have observed this only in two cases out of 200 arms (all were in the right arm). The other variations appeared in two cases (one on the right, one on the left), where the basilic vein was very weak. But in this case the v. cephalica accessoria, arising from the ulnar end of the rete venosum dorsale manus, was very strong in compensation.

² Carle, Recherches sur la veine basilique. Application à la ligature de l'axillaire. Bull. et Mém. soc. anat. Paris, Année 75, Sér. 6, T. 2.

C. The v. mediana cubiti (B.N.A.)

This is the connecting vein which normally leads obliquely upward in the flexure of the elbow from the v. cephalica to the v. basilica and has an anastomosis with the deep veins. This vein was present in 85.5 per cent (89 per cent on the right, 82 per cent on the left), which corresponds with the study of Berry and Newton (84 per cent in their case). The cases where the v. mediana antibrachii terminated in the v. mediana cubiti were much more frequent than in Europeans. In 54.5 per cent (56 per cent on the right, 53 per cent on the left) I have found these types (43 per cent in Europeans, after Berry and Newton). The vein arose from the v. cephalica much more distally than usual in 3 per cent (on the right side only one case and on the left six cases). I have observed sometimes the abnormalities of the reduplication of this vein, i.e., in 8.5 per cent (10 per cent on the left, 7 per cent on the right). Absence of this vein was found much more often than its reduplication, i.e., in 14.5 per cent in my cases (11 per cent on the right, 18 per cent on the left).

D. The v. mediana antibrachii (B.N.A.)

The v. mediana antibrachii is found to be the main outlet of the rete venosum volare manus. It passes proximally along the ulnar side of the volar surface of the forearm to a variable termination in the vicinity of the elbow-joint. Sometimes it makes a loop in the vicinity of the v. mediana cubiti, which receives the v. mediana antibrachii. The termination of this vein in my case is as follows:

1. It terminated in the v. basilica, 44 per cent (44 per cent on the right, 44 per cent on the left).
2. It terminated in the v. mediana cubiti, 54.5 per cent (56 per cent on the right, 53 per cent on the left).
3. It terminated by dividing into the v. mediana basilica and the v. mediana cephalica only in two cases in my 200 subjects. This type was usually described as an M-shaped arrangement of the veins in front of the elbow.

4. It terminated in a loop which lies in the vicinity of the v. mediana cubiti. Each end of this loop opened in to the v. mediana cubiti or the ulnar one in the v. basilica, 13.5 per cent (16 per cent on the right, 11 per cent on the left).

E. The veins on the dorsal side of the hand

From the union of every pair of the arcus venosus digitalis arise four larger vv. metacarpeae dorsales. These form sometimes the rete venosum dorsale manus as in B.N.A. and sometimes the arcus venosus dorsalis manus as noted by Berry and Newton. The large vein passing from the center of the concavity of the arcus venosum dorsale manus proximally to terminate into the v. cephalica or the v. basilica is called the v. ascendens. The radial extremity of the arcus or of the rete venosum dorsale manus receives vv. digitales propriae of the index-finger, as well as both the similar veins of the pollux. The large vein issuing from the ulnar end of the arcus venosus dorsalis manus and passing obliquely proximally and radially to terminate in the v. cephalica is called the v. obliqua. In my case I have the result as follows:

1. The arcus dorsalis venosus manus, 70 per cent (75 per cent on the right, 65 per cent on the left).
2. The rete venosum dorsale manus, 30 per cent (25 per cent on the right, 35 per cent on the left).
3. Presence of the v. obliqua, 41 per cent (44 per cent on the right, 38 per cent on the left).
4. Presence of the v. ascendens, 27.5 per cent (23 per cent on the right, 32 per cent on the left).

F. Abnormalities

The abnormalities in the superficial veins of the superior extremity in my studies were as follows:

1. The reduplication of the v. mediana cubiti was found in 8.5 per cent (7 per cent on the right, 10 per cent on the left).
2. The v. mediana cubiti was absent in 14.5 per cent (11 per cent on the right, 18 per cent on the left).

3. Connection between the *v. cephalica* and the *v. cephalica accessoria* was found in 2.5 per cent (3 per cent on the right, 2 per cent on the left).

4. The *v. cephalica* did not give off the *v. mediana cubiti* in 14.5 per cent (10 per cent on the right, 19 per cent on the left).

5. The *v. cephalica* arose from the ulnar end of the *arcus venosus dorsalis manus* or the *rete venosum dorsale manus* and the radial end of the *arcus* or the *rete* passed proximally to the forearm and terminated in the *v. basilica* in the elbow flexure. In these cases the *v. mediana cubiti* was sometimes absent and the *v. mediana antebrachii* terminated in this abnormal vein. I have found this abnormality in 6 per cent (7 per cent on the right 5 per cent on the left).

6. The connection between the *v. cephalica* and the *v. mediana antibrachii* was found in 4.5 per cent (4 per cent on the right, 5 per cent on the left).

7. The *v. cephalica* was very weak in 4.5 per cent (2 per cent on the right, 7 per cent on the left). This abnormality combined often with abnormality 5. The absence of the brachial portion of the *v. cephalica*, which was found by Berry and Newton, was not seen in my cases.

8. The abnormal connection between the *v. basilica* and the *v. cephalica* in the upper arm was found in 3 per cent (2 per cent on the right, 4 per cent on the left).

9. The loop in the *v. mediana antebrachii* was found in 13.5 per cent (16 per cent on the right, 11 per cent on the left).

10. In case no. 61 (student twenty-five years) I have observed a very rare abnormality. The *v. cephalica* arose from the ulnar side of the *rete venosum dorsale manus* and ran proximally and terminated in the *trigonum deltoideopectorale*. In the right arm, the radial end of the dorsal veins of the hand arose normally and in the middle of the upper arm turned obliquely to the *fossa axillaris* and the terminated in the *v. axillaris*. In the left arm the *v. cephalica* at the fore margin of the *m. pectoralis major* gave off an abnormal branch to the axillary vein.

11. In case no. 26 (student twenty-two years) the v. cephalica in the right arm was duplicated. The lateral one arose from the v. ascendens.

12. In case no. 87. (student twenty-five years) I have found two loops in the flexure of the elbow in the left arm, in which vv. medianae antibrachii terminated.

PLATE 1

EXPLANATION OF FIGURES

1 No. 3 Twenty-four years old, right arm. The v. cephalica with 'Inselbildung.'

2 No. 11 Twenty-three years old, right arm. The v. basilica with 'Inselbildung.' The v. cephalica accessoria is present.

3 No. 29 Twenty-three years old, left arm. The duplication of the v. mediana cubiti is present.

4 No. 87 Twenty-five years old, right arm. The v. mediana antibrachii makes a loop in the vicinity of the elbow flexure.

5 No. 87 Twenty-five years old, left arm. The v. mediana antibrachii makes double loops.

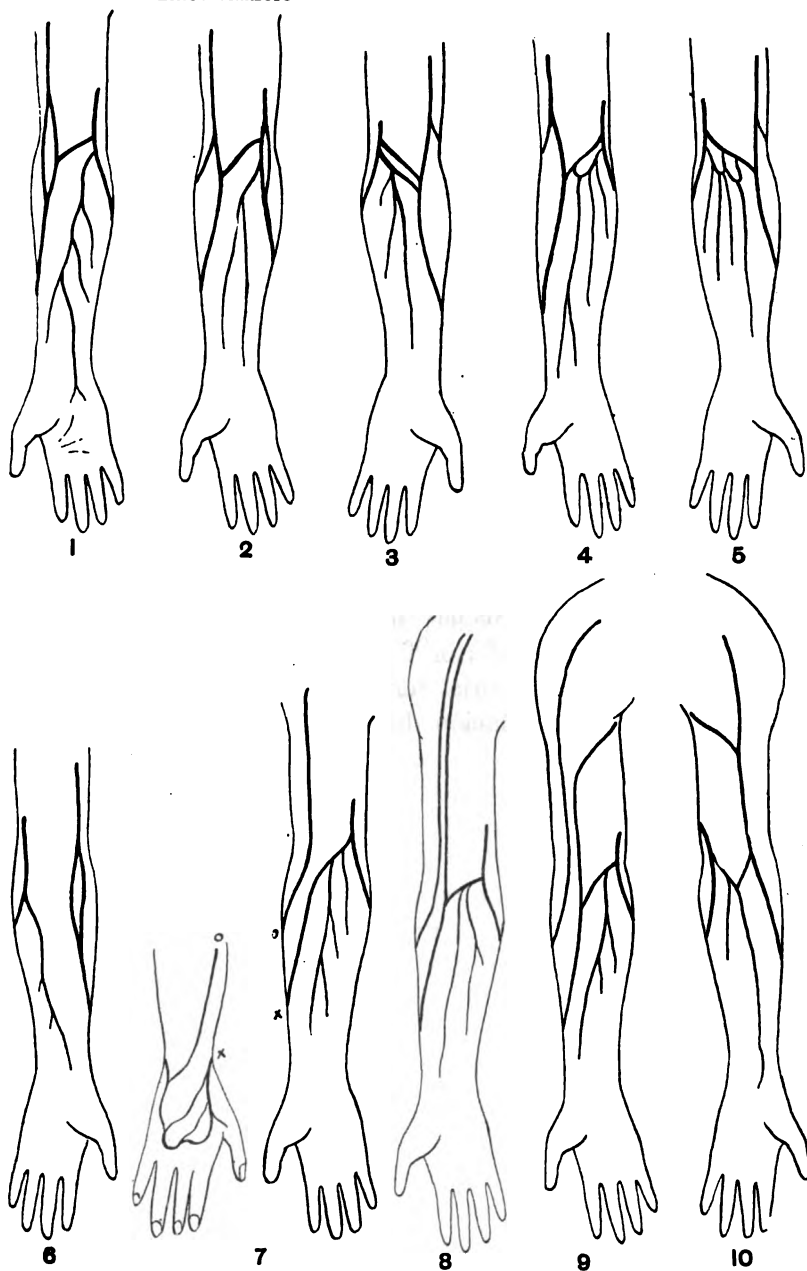
6 No. 53 Twenty-six years old, left arm. The v. mediana cubiti is absent and the v. cephalica makes an 'Insel.'

7 No. 50 Twenty-five years old, right arm. The radial origin of the v. cephalica terminates in the v. basilica and the ulnar origin (corresponds with the accessorial origin) runs to the normal termination.

8 No. 26 Twenty-two years old, right arm. The reduplication of the v. cephalica is present, but the lateral one arises from the ulnar side of the dorsal veins of the hand.

9 No. 61 Twenty-five years old, right arm. The v. cephalica arises from the radial side of the dorsal veins of the hand and terminates in the v. axillaris. The lateral one arises from the ulnar side of the dorsal veins of the hand, and runs to the normal termination.

10 No. 61 Twenty-five years old, left arm. The v. cephalica gives an abnormal branch to the v. axillaris at the proximal third part of the upper arm. The v. mediana antibrachii divides into the v. mediana cephalica and the v. mediana basilica.



Resumen por el autor, William W. Looney.

Una vena espermática interna derecha aberrante.

En un sujeto mejicano, de unos veinticinco años de edad, fallecido de tuberculosis, ha encontrado el autor una vena espermática derecha aberrante la cual penetraba dentro de un hilus secundario situado cerca del polo inferior del riñón derecho, en compañía de una arteria renal accesorio, terminando en un vaso tributario de la vena renal. La relación de los vasos renales era también inversa de la normal.

Translation by José F. Nonides
Cornell Medical College, New York

AN UNUSUAL ABERRANT RIGHT INTERNAL SPERMATIC VEIN

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ONE FIGURE

The following observation was made on a Mexican male, about twenty-five years old, who died in Parkland Hospital of tuberculosis and was dissected during the first term of the present school year.

After the small intestine had been dissected and removed together with the mesentery, the peritoneum was stripped from the right psoas muscle. The right internal spermatic vessels were exposed just above the brim of the pelvis and traced upward. In following the vessels towards their origin and termination, it was found that the vein, instead of following the course of the artery, diverged to the right in the direction of the kidney.

On exposure of the hilus and lower pole of the right kidney, an accessory renal artery was found entering a distinct secondary hilus near the inferior pole of the kidney, accompanied by the internal spermatic vein. After removing a small portion of the anterior surface of the kidney (fig. 1), the internal spermatic vein was found to enter one of the tributaries of the renal vein.

It will also be noted from the figures that the ordinary relation of the renal artery and vein was reversed in this particular case.

Our recent texts and journals report cases in which the right internal spermatic vein enters the right renal vein, but none of them mentions cases parallel with the one described above.

Evidently, during differentiation of the kidney, the internal spermatic vein was included in the surrounding kidney substance and maintained in this position, thereby causing it to

terminate in a tributary of the renal vein, instead of in the main renal vein, as is ordinarily found in such cases.

It is interesting to note that had this particular kidney been removed during life, serious results would have followed in the right testicle, without the surgeon's being necessarily to blame.

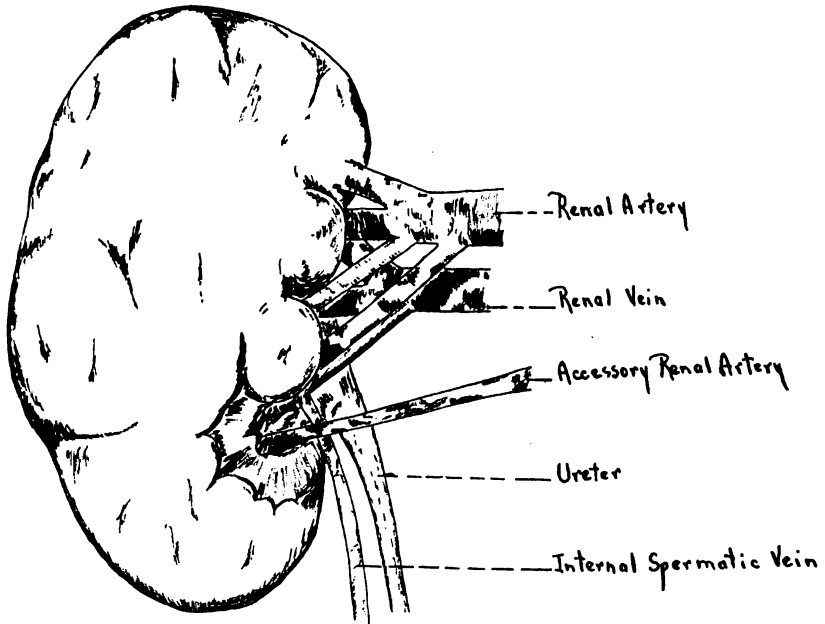


Fig. 1 Right kidney, with a portion near the lower pole cut away to show secondary hilus, accessory renal artery, and internal spermatic vein joining a tributary of the renal vein.

SOME UNIFORM CHARACTERISTICS OF THE PRIMATE AURICLE

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Carnegie Embryological Laboratory, Baltimore, Maryland

FOURTEEN FIGURES

In the attachment of the auricle to the side of the head there are certain physical requirements that must be met. The auricle must, of course, be held securely in place and at the same time it must possess a varying degree of motility and power of direction; its shape must be maintained for the efficient collection of sound vibrations, and provision must be made by some closure device to protect the external acoustic meatus from the entrance of foreign substances, particularly in burrowing and aquatic animals. In studying the striking differences in structure exhibited by the auricle in the various animal forms, one finds that most of their auricular individualities are in the nature of remarkable morphological adaptations to these varying physical requirements. Perhaps the most constant requirement is that the auricle be securely attached. In consequence one would expect to find that portion of the auricle concerned in this function to be less variable in form than its other parts. This appears to be true, at any rate for the Primates, and it is the purpose of this communication to call attention to this relatively constant articular provision and its expression in the form of the auricle.

The existing terminology of the external ear is a purely descriptive one and is based upon the form usually met with in the human adult. During the period of its inauguration scant attention was given to the embryonic stages and as little to the ear of other animals. It is therefore not surprising that one finds it more or less inadequate for any functional analysis of

the auricle or for the study of any ear other than that of adult man. When an appropriate time comes the nomenclature of the external ear, as much as any other part of the body, will need a thorough reconsideration. For the present, I am departing very little from the prevalent terminology, and then only where it seems unavoidable. As can be seen in figure 2, the following substitutions have been made: *fossa articularis superior* (for *fossa triangularis*), *fossa articularis inferior* (for *cymba concha*), *plica principalis* (for *crus inferius anthelcis*),¹ and *crus helcis* to include all that part of the helix derived from the mandibular arch. Furthermore, on the median side of the cartilage, corresponding to the articular fossae, there are the superior and inferior articular eminences, partially separated by the groove of the principal fold. It is to these eminences that I would first of all direct the reader's attention.

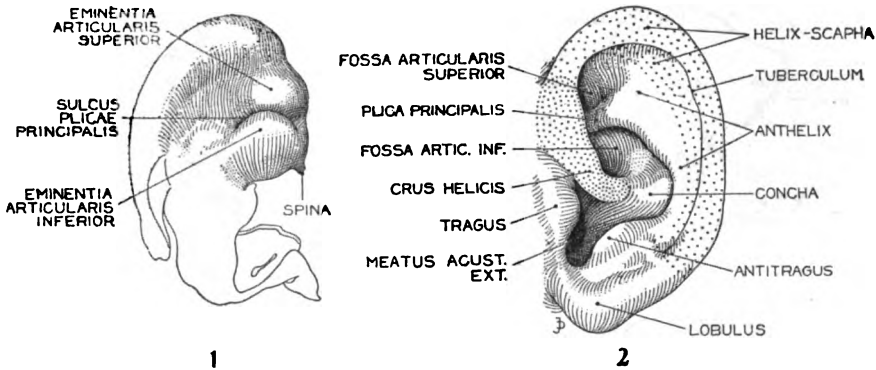
The two articular eminences (fig. 1) are continuous with each other anteriorly and together constitute a relatively rigid, bowl-shaped base from which the auricle is suspended. It is only this part of the auricular cartilage that offers a contact surface suitable for its attachment to the skull, and it may therefore be designated as the *pars articularis*. Nearly the whole of the inferior eminence contributes to this surface, whereas, of the superior eminence, only the forward and lower portions take part. It is true that the band-like, fenestrated cartilage surrounding the external acoustic meatus also has a bony attachment, but this is quite different in character and is to be compared rather to the tracheal rings, serving as a mechanism to prevent a collapse of the meatus. In structure and position it offers little if any support to the auricle.

The articular eminences are attached to the periosteum by a fibrous ligament sufficiently loose to permit free movement of the auricle. The extrinsic ear muscles are attached around the margins of the eminences. The superior auricular muscle is inserted into the superior eminence, the posterior auricular muscle into the conchal wall immediately adjoining the inferior

¹ I am adopting the term *plica principalis* as used by Boas (Ohrknopel und äusseres Ohr der Säugetiere. Kopenhagen, 1912).

eminence, while the anterior auricular muscle is inserted at the base of the spina. It is to be noted that the spina is in reality a process of the pars articularis, from that portion where the inferior articular eminence merges into the crus helcis.

As for the crus helcis, this is not, strictly speaking, a part of the helix, from which it differs both embryologically and structurally, as I have pointed out elsewhere.³ It merges with the helix as a continuous fold, but one can always recognize the point of junction of the two at about the level indicated in

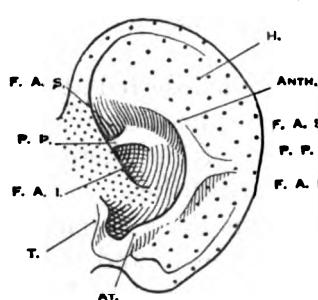


Figs. 1 and 2 Human adult auricle. In figure 1 the auricular cartilage is viewed from the median side, showing the two eminences that constitute its main area of contact with the skull. In figure 2 can be seen the cavities (fossae articulares) of these eminences with the plica principalis projecting between them as a strengthening ridge. The articular fossae are continuous with and constitute a specialized part of the concha, the pars articularis. The crus helcis and the cartilaginous spina are also parts of this attachment mechanism.

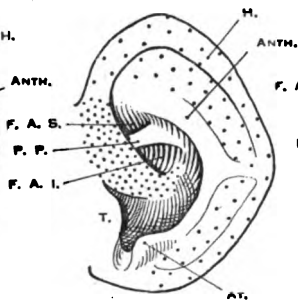
figure 2. The crus helcis constitutes, first of all, the lateral rim of the bowl-shaped pars articularis and only secondarily acts as a support to the anterior end of the helix.

So much can be readily seen in the adult ear. In the human embryo and fetus the entity of a pars articularis is even more pronounced. It is the first part of the auricular cartilage to acquire its distinctive form and is more or less bowl-shaped from the outset, forming a cap over the upper end of the first

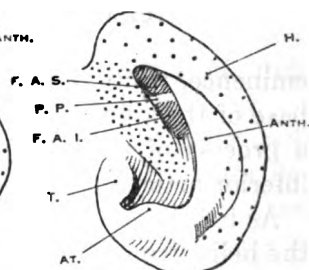
³ Streeter: Embryological significance of the crus helcis. *Anat. Rec.*, vol. 18, 1920.



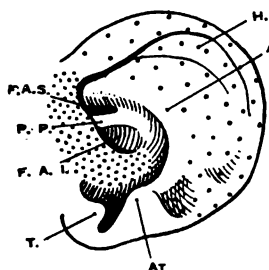
3. Chimpanzee



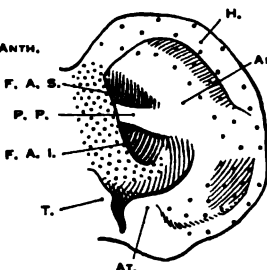
4. Gorilla



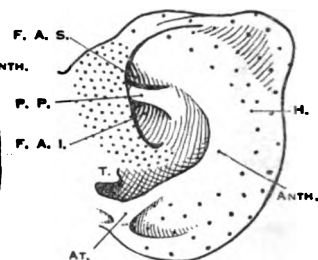
5. Orang-utan



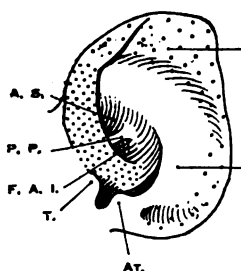
6. Gibbon



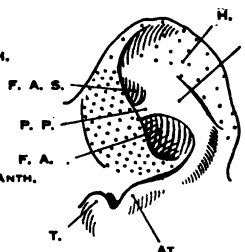
7. Proboscis-monkey



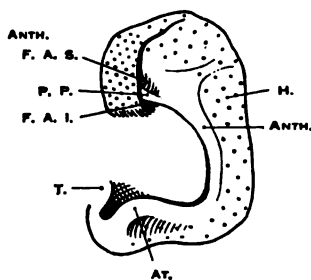
8. Macaque



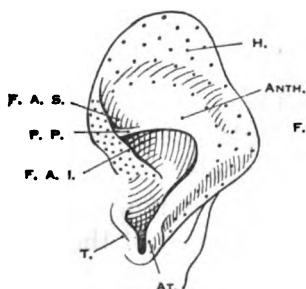
9. Baboon



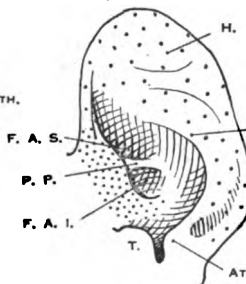
10. Spider-monkey



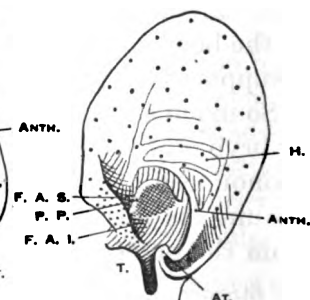
11. Howler



12. Marmoset



13. Lemur



14. Tarsius

Figures 3 to 14

gill cleft. It has a marked oral process (spina) extending forward into the mandibular arch and its lateral rim (crus helicis) is well defined. The floor, projecting against the skull, is early subdivided into two fossae by the plica principalis, which can be recognized in the 43-mm. fetus and is well-pronounced in 50-mm. specimens. That portion of the floor corresponding to the inferior articular eminence is relatively larger, as compared with that of the superior, than obtains in the adult. The pars articularis is directly continuous with the concha and unquestionably should be considered a part of it. The latter spreads down towards the region of the antitragus and the meatus. In embryos less than 30 mm. long this portion of the concha is still fenestrated, which condition is more marked and remains permanent in the region of the meatus. The presence of the scapha, with its characteristic rolled edge (helix) is indicated early, but is relatively small and its growth slow until the later fetal stages.

Turning from these considerations to a survey of the auricle of other Primates, we find a striking constancy in the form of that portion concerned in its attachment—the pars articularis. A representative series of Primates is shown in figures 3 to 14. For convenience in arrangement, these figures are drawn at about the same size and so are at different enlargements. This treatment tends to minimize the marked differences in size actually prevailing in the scapha and helix in these different forms, and

Figs. 3 to 14 In these sketches the helix and scapha are dotted and the crus helicis is indicated by closer dots. Abbreviations: *ANTH.*, anthelix; *AT.*, antitragus; *F.A.I.*, fossa articularis inferior (cymba concha); *F.A.S.*, fossa articularis superior (fossa triangularis); *H.*, helix and scapha; *P.P.*, plica principalis (crus inferius anthelicis); *T.*, tragus. Most of these sketches were made from preserved specimens kindly lent to me by Dr. Adolph H. Schultz, and the species as identified by him are herewith given. (In the four specimens obtained elsewhere the source is mentioned.) Figure 3, *Troglodytes niger*, copied from figure V, page 214, of Boas ('12); figure 4, *Gorilla gorilla*, from photograph issued by the New York Zoological Society; figure 5, *Pongo pygmaeus*; figure 6, *Hylobates concolor*; figure 7, *Nasalis larvatus*; figure 8, *Pithecus philippinensis*; figure 9, *Papio porcarius*; figure 10, *Ateles variegatus*; figure 11, *Alouatta seniculus*; figure 12, *Hapale rufimanus*, copied from figure 243, Tafel 23, of Boas ('12); figure 13, *Lemur variegatus*; figure 14, *Tarsius spectrum*, from specimen belonging to Dr. H. Woollard.

at the same time tends to give the impression of a greater variation in size in the other parts than really exists. In contrast to the variable scapha and helix, the parts composing the pars articularis (crus helicis, superior and inferior fossae, and the principal fold) exhibit about the same form and relations in each figure.

The principal fold is a little more variable in size than the other parts of the attachment mechanism, although its relations are essentially the same in each case. Where it is particularly well marked it comes to the level of and fuses with the rim of the concha (anthelix), as usually occurs in man. It was this relation which led to the term 'crus inferius anthelicis.' Where it is not so well developed it does not reach the conchal brim and is thus not continuous with the anthelix. Certainly, in most Primates one cannot properly speak of it as a crus of the anthelix. Since the figures show the chief points that I wish to bring out, it will not be necessary to describe them here individually. It may, however, be well to call attention to the *Tarsius* specimen^{*} as the most discordant one in the series. One of its peculiarities is the extraordinary development of what appears to be the principal fold. Instead of constituting a simple strengthening ridge, the fold projects from the conchal floor as a free flap, somewhat of the nature of a similar structure seen in certain bats.

In view of the above observations, we can briefly analyze the form of the primate auricle somewhat as follows: The auricle consists of a primary part (concha), a rigid, shell-like support which is relatively constant in form, and a secondary part (scapha-helix-lobule) which flares from the caudal rim (anthelix) of the concha and is exceedingly variable both in size and form.

The concha in turn may be subdivided into a lower half (cavum conchae), which serves as an approach to the meatus and at the same time provides a closure mechanism by the specialization of its antero-inferior walls, and an upper half

^{*} For the privilege of studying this valuable specimen I am indebted to Dr. H. Woollard, of University College, London.

(pars articularis), which constitutes an attachment base from which the auricle as a whole is suspended.

The pars articularis comprises several elements, all of which contribute to its effectiveness. a) The superior and inferior articular eminences offer jointly an attachment surface which comes in direct contact with the skull. These eminences are separated by a groove or strengthening fold which in a lateral view projects as the plica principalis, separating the two fossae that correspond to the eminences. b) The spinous process (spina) offers a point for ligament and muscle insertion. c) The crus helcis forms the anterolateral rim of the pars articularis, its upper end supporting and merging into the helix. Below, it marks the transition of the pars articularis into the lower part of the concha. Including, as we thus do, the pars articularis in the concha, the so-called superior crus of the anthelix becomes simply the upper end of the anthelix, or, in other words, the superior rim of the concha.

Resumen por el autor, Ferdinand C. Lee.

Sobre los vasos linfáticos de la pared de la aorta torácica del gato.

En vista de los escasos conocimientos sobre la irrigación linfática de las paredes de las arterias, el autor publica sus observaciones sobre un ejemplar que indica que en la aorta del gato existe un plexo extenso de capilares linfáticos situado entre las tunicas media y adventicia, mientras que más superficialmente, en la última, existe un plexo de grandes vasos linfáticos los cual es a veces se anastomosan con el plexo situado más profundamente. El ejemplar descrito es un gato en el cual se llevó a cabo la ligadura intratorácica del conducto torácico. Tres semanas después de la operación el animal fué sometido a la acción del éter, inyectando los linfáticos del mesenterio con una solución acuosa saturada de azul de Berlin. La masa de inyección penetró en el torrente circulatorio a través de una conexión linfático-venosa e incidentalmente llenó algunos de los linfáticos de la pared de la aorta.

Translation by José F. Nonides
Cornell Medical College, New York

ON THE LYMPHATIC VESSELS IN THE WALL OF THE THORACIC AORTA OF THE CAT

FERDINAND C. LEE

Anatomical Laboratory of the Johns Hopkins University

TWO FIGURES

During the course of an investigation involving the intra-thoracic ligation of the thoracic duct of the cat (4), a specimen was obtained which showed to some extent the distribution of lymphatic vessels in the wall of the thoracic aorta. Since the lymphatics of blood-vessels are as yet imperfectly understood, it was considered that the specimen justified this brief report.

The specimen was obtained from an adult male cat whose thoracic duct was ligated according to a method previously described. The animal made an uneventful recovery from the operation, gained slightly in weight, and twenty-one days following the ligation was sacrificed in the following manner. While under the influence of ether, the abdomen was opened and the mesenteric lymphatic vessels were injected with a saturated aqueous solution of Berlin blue, using an ordinary hypodermic syringe with a needle of 28 G. After about 20 cc. of the suspension had been injected, the animal was sacrificed. It was immediately seen that the thoracic duct had been securely ligated, that a lymphaticovenous connection had become established between the thoracic duct and the ninth left intercostal vein, and that a plexus of vessels containing the injection mass existed in the wall of the aorta. The entire trunk of the animal was fixed in 10 per cent formalin, and a few days later a block of tissue containing the lower half of the thoracic aorta and the surrounding tissues was dissected away, dehydrated in alcohol, and cleared according to the Spalteholz method.

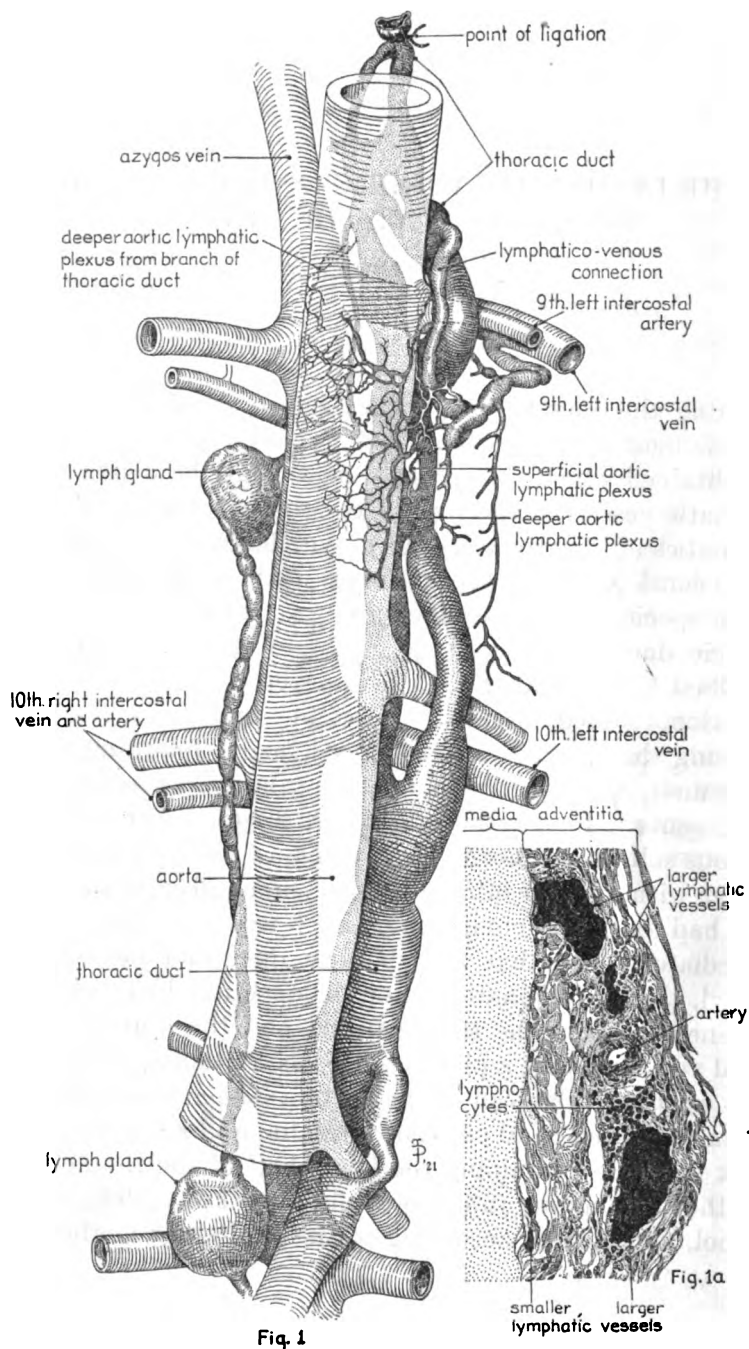
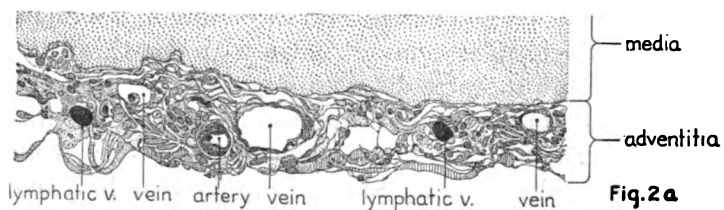
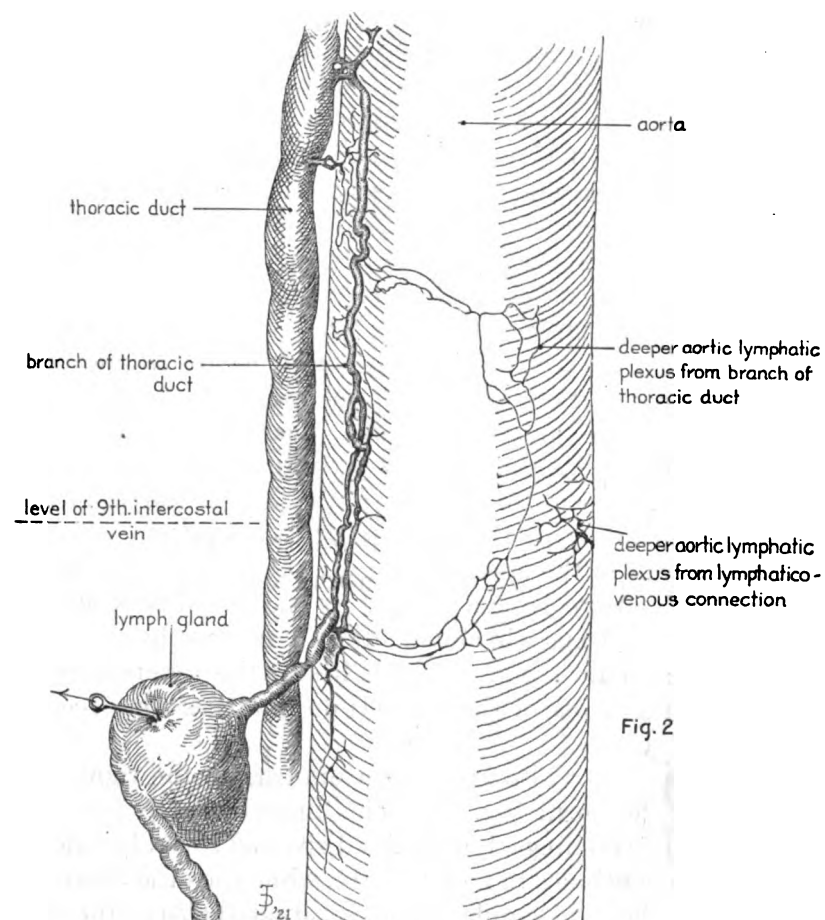


Figure 1 is a drawing of this specimen as viewed anteriorly. It shows the thoracic duct passing along the thoracic aorta and being pierced, as it were, by successive intercostal arteries. Below the point of ligation the thoracic duct suffers a limited plexiform change, and then, immediately above the ninth left intercostal artery, it gives off a vessel which courses inferiorly and after making several turns goes superiorly and empties into the ninth left intercostal vein. From this lymphaticovenous connection, which possesses numerous valves, vessels come off to form a more superficial and a deeper plexus; the superficial portion in the periadventitial tissue has only a few branches (not striped in the drawing) which communicate at one point with the deeper aortic plexus lying well within the adventitia of that vessel. The lymphaticovenous channel also gives off several branches which course inferiorly in the loose periaortic tissue. The structure of interest is the deeper aortic plexus, which lies definitely in the adventitia; the depth to which it pierces the wall of the aorta is shown in figure 1a. The larger vessels of this plexus have a few valves and soon break up into a rich capillary plexus which extends well over to the right side of the aorta. This capillary plexus lies at the junction of the adventitia and media of that vessel; no branches were seen to pass into the media.

The thoracic duct also gives off a branch, on the right side, posterior to the aorta (fig. 2). This branch courses inferiorly and just before reaching a lymph gland gives off several branches, one of which continues to go inferiorly, while the other branches form a small plexus of capillary vessels, situated also at the junction of the adventitia and media, and extending in a semicircular shape superiorly until it communicates with the thoracic duct. The branch of the thoracic duct leading to the lymph gland is double for a part of its lower course and is abundantly provided with valves. The fine capillary plexus arising in part from this vessel resembles the capillary plexus from the lymphaticovenous connection both in shape and location. These two plexuses approach each other closely at one point, and although the injection shows no continuity between the two, nevertheless a



small uninjected capillary, discernible with great difficulty, seems to connect one plexus with the other. Along the deeper aortic plexus arising from a branch of the thoracic duct, as shown in figure 2, other vessels, uninjected and paler than the surrounding medium, are seen to course parallel with the lymphatic vessels. These pale uninjected vessels are vasa vasorum and are shown in cross-section in figure 2a.

DISCUSSION

Very little is known about the lymphatic vessels in the walls of vessels. Stroganow (7) undoubtedly was dealing with tissue spaces and not true lymphatic vessels in the work which he reported in 1876. Hoggan and Hoggan (3) in 1883, using the silver-nitrate and gold-chloride method in staining the vascular endothelium of the horse, concluded that no lymphatics exist on the inner side of vessel musculature, whether this musculature be in arteries, veins, or large lymphatic trunks, and that only in those large veins or lymphatics in which the muscular coat is absent is there a plexus of lymphatics immediately underneath the lining endothelium.

In 1897 Schiefferdecker (6), using silver lactate, prepared specimens from the pig's aorta that showed a lymphatic plexus directly under the endothelium. Thus he supplemented the work of Hoggan and Hoggan, who found a subendothelial lymphatic plexus only in those vessels in which the muscular coat was absent.

Delamere (2) in 1904, in his classical treatise on the lymphatics stated that the "existence of arterial lymphatics, however probable, is still a mooted point." Bartels (1) in 1909, in his well-known work on the lymphatic system, did not give any new facts concerning the arterial lymphatics.

It is thus obvious that any light which may be thrown on the subject of arterial lymphatics must be of value. It is at once recognized that the specimen here described was obtained from an animal which was subjected to certain operative procedures to its thoracic duct, and from that point of view does not represent a specimen from a strictly normal animal. However, it does give an idea of the general distribution and arrangement

of arterial lymphatics. It shows that the lymphatics to the aorta form not only a superficial, less evident plexus situated in the peripheral portion of the adventitia, but that deeper in the vessel wall, at the junction of the adventitia and media, an extensive capillary lymphatic plexus exists. The larger branches of this deeper lymphatic plexus run parallel with the vasa vasorum of the bloodstream, thus giving the familiar vascular triad of artery, vein, and lymphatic. It also demonstrates how the smallest injected lymphatic capillary is eventually connected with the thoracic duct, without the interposition of a lymph gland (cf. Bartels (1)).

The determination of the exact character of the plexus arising from the lymphaticovenous connection proper is of importance. Whether this vessel that connects the thoracic duct with the ninth intercostal vein is a lymph vessel or a vein is difficult to decide. Yet the fact that this connecting vessel is tortuous, has so many valves, and gives off vessels which have valves makes one inclined to call it a lymph vessel. And besides it is difficult to consider it a vein because it joins the thoracic duct almost at right angles, whereas ordinarily the typical entrance of a lymph vessel into a vein (e.g., the entrance of the thoracic duct into the junction of the subclavian and internal jugular veins), is such that the lymph vessel makes an acute angle with the vein, and the direction of the current in these two vessels is essentially the same. This arrangement of course facilitates the aspiration of the lymph into the vein. But the direction of the current in the lymphaticovenous connection is opposite to that in the thoracic duct; it thus becomes increasingly difficult to look upon this connecting vessel as a vein. On the other hand, the connecting vessel joins the ninth intercostal vein in such a way that the direction of their respective currents is about the same. The presence of numerous valves in this connecting vessel argues strongly against its interpretation as a vein, because veins of such a small caliber rarely have valves (Schäfer (5)), and if they do have valves, these would probably not be as numerous as the ones in the lymphaticovenous connection.

Granted that the lymphaticovenous connection is essentially a lymph-vessel, then the plexus of vessels which comes from this connection must also be considered lymphatic in character. But, although there are indications of valves in the larger branches of the plexus, nevertheless this entire plexus gives the impression of being venous in character.

As much as one may doubt the lymphatic nature of the plexus communicating with the lymphaticovenous connection, one is all the more sure of the true lymphatic character of the small plexus of vessels in the posterior portion of the aorta. This plexus of vessels communicates only with definite lymphatic trunks, and is therefore definitely lymphatic in character. The finer divisions of this plexus resemble in general appearance and lie at the same depth as the finer vessels of that plexus derived from the lymphaticovenous connection. Unfortunately, no injected vessel was seen to establish the continuity between these two plexuses.

It is a pleasure to thank Mr. J. F. Didusch for the excellent illustrations.

SUMMARY

In view of the meager knowledge of the lymphatic supply to the walls of arteries, a specimen is reported here which shows that in the aorta of the cat an extensive plexus of lymphatic capillaries lies at the junction of the media and the adventitia, while more superficially in the adventitia there is a plexus of large lymphatic vessels which occasionally anastomose with the plexus more deeply situated.

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AN ACCESSORY PANCREAS IN THE WALL OF THE GALL BLADDER OF A DOG

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TWO FIGURES

In a previous report I recorded the finding of accessory pancreases in two dogs.¹ I herewith report a third case, which is of interest because of the unusual position of the pancreas, in the wall of the gall bladder. The wide distribution of accessory pancreases along the stomach and small intestine, and the fact that the ventral pancreas normally communicates with the bile duct, lead one to anticipate the possibility of finding occasionally an aberrant gland opening into the gall bladder, but thus far there seems to be no case on record of such an occurrence. Lobes of pancreas extending outward along the bile ducts to the region of the gall bladder have occasionally been reported in the cat, but these are anomalies of quite another sort.

THE FINDING OF THE GLAND AND ITS DESCRIPTION

Dog F 212 (Experiment 216-22). A brown and white female adult mongrel fox terrier. The dog's abdomen was opened, February 22, 1922, in order to ligate the common bile duct for the purpose of studying certain phases of obstructive jaundice. On inspecting the biliary tract, a small mass, noted on the surface of the gall bladder, grossly appeared to be pancreatic tissue. The gall bladder was removed and also a small specimen of the free duodenal portion of the pancreas. The liver and pancreas were normal grossly.

The gall bladder was normal in size, measuring 5 cm. in length and 2.5 cm. in width at the broadest portion. The mass, which

¹ Mann, F. C.: Accessory pancreas in the dog. *Anat. Rec.*, 1920, xix, 263-268.

proved to be an accessory pancreas, was located squarely on the free or inferior surface of the gall bladder, and extended backward from the beginning of the neck. It was roughly elliptical in shape. The long axis measured 1.5 cm. and the short axis 1 cm.; it varied from 2 to 4 mm. in thickness. The surface of the gland on the serosa side was irregular and lobulated like a normal pancreas, except that the lobules were small. The mucous membrane of the gall bladder over the gland was not broken, and did not appear different from any other portion, except that there were three pin-point openings. Under the dissecting microscope these appeared to be the openings of ducts. Unfortunately, in the histological sections which were made, it was impossible to follow any of the ducts through to an orifice in the gall bladder, although these ducts were present near the site of the apparent openings. The blood supply to the gland was generous (fig. 1).

Microscopic examination showed the gland to be composed of pancreatic tissue similar to that of the major pancreas (fig. 2). It was normal, except that the acini seemed to be rather small, and there were no well formed islands. There were a few large ducts and several small ones. The acinar cells were closely packed giving a compact appearance to the gland. Small groups of cells apparently island cells, usually not more than six in number, were found at intervals. The careful study of many slides of three accessory pancreatic glands in the dog demonstrated one characteristic common to all, namely, the very small amount of island tissue. In the present case, after a prolonged search, a few definite but very small islands were found. The condition of the acinar tissue in connection with a well developed duct system definitely indicated an active gland, and it was absolutely isolated in every respect from the major pancreas. We examined very carefully around the bit of pancreatic tissue for some indication of a connection between it and the major pancreas, but none was found. Histological sections through the inferior end of the accessory gland failed to disclose any evidence of such a connection. The larger ducts as before noted were toward the gall bladder, into which undoubtedly the secretion was discharged.

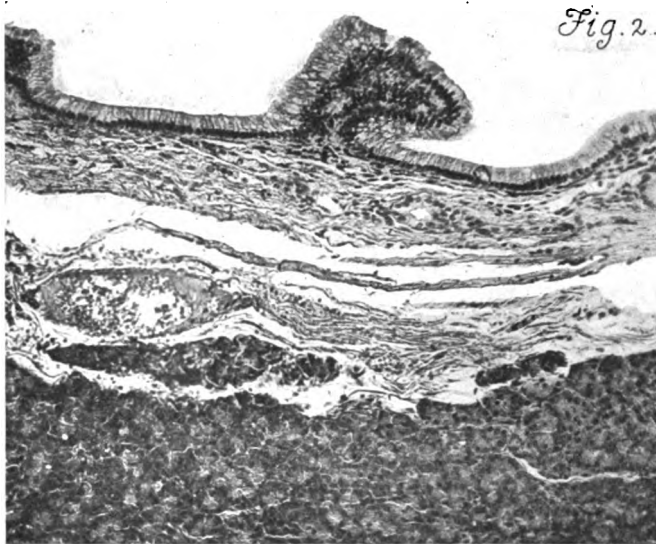


Fig. 1 Drawing of the gall bladder, showing the relative position and size of the accessory pancreas.

Fig. 2 Photomicrograph of section of accessory pancreas and gall-bladder wall. The gland was located just under the serosa. ($\times 100$).

Resumen por el autor, Benjamin T. Nelson.

El número de glomérulos en el riñón del conejo adulto.

El autor ha contado los glomérulos en riñones, en los cuales dichos elementos se habían teñido previamente mediante coloración supravital con verde janus. En uno de ellos ha contado el autor el número total, que resultó ser 163,075. En otros ocho riñones procedentes de cuatro animales, cálculos basados en el peso total de la corteza y en el recuento de un riñón previamente pesado han resultado en cifras que oscilan entre 118,160 y 168,966. Con una sola excepción el número de glomérulos encontrado excede 154,000, y el número medio para todos ellos, incluyendo el riñón contado in toto es 157,180. El número de glomérulos en cada riñón del conejo adulto es por consiguiente unos 160,000, próximamente.

Translation by José F. Nonidez
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THE NUMBER OF GLOMERULI IN THE KIDNEY OF THE ADULT RABBIT

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The number of glomeruli in a kidney is a measure of the number of uriniferous tubules, and as such a necessary factor in estimating the relative surface of glomerular and tubular epithelium concerned in the secretion of the urine. It is also an important element in Brodie's computation of the pressure necessary at the glomerular end of the tubule to drive the urine along the tubule at the rate at which it is secreted in diuresis.

The earliest enumeration of the tubules is credited to Eysenhardt (1818), whose article I have, unfortunately, been unable to consult. According to Huschke ('44), Eysenhardt estimated the tubules of the human kidney at 42,000,000—a number which Huschke criticised as probably much too high because of the enumeration of blood vessels as tubules. Through an error Huschke is usually credited by authors as the first to enumerate the glomeruli, but his article in Oken's *Isis*, vol. 21, 1828, to which reference is made by Brodie, Policard, and others, contains no mention of the number, except the remark that they are more numerous, relative to mass, in the young than in the adult. Not until 1844, however, did Huschke discuss the actual number of tubules in the human kidney. In his article entitled "Eingeweidelehre" in Sömmering's *Bau des menschlichen Körpers* he said: "Every kidney lobe contains about 700 kidney lobules and each lobule about 200 cortical canals. If the kidney has 15 lobes that would give it 10,500 lobules and 2,100,000 cortical canals."

In his classical work on the kidney published in 1865, Schweigger-Seidel ('65) describes his method of determining the number of glomeruli in the kidney of the pig and discusses the results.

After carefully separating the cortical substance from the rest of the renal substance, he found, in a kidney weighing 120.5 grams, 102 grams of cortex. Small weighed portions of this cortex were teased and macerated in hydrochloric acid to permit the separation of the glomeruli for counting. In a total weight of 15.5 cgm. he found 720 glomeruli, and calculated the total content of the kidney as 473,200 glomeruli.

Peter's ('09) estimate of the number of tubules in the cat is based on the mode of branching of the ducts. He says: "Bei der Katze ergeben sich stets 4 initiale Aeste und meist 7 zentrale Teilungen; auf einen ins Becken mündenden Gang entfallen damit (2^s). 4 Kanälchen, d.h. 1024; nehmen wir die Zahl der Sammelröhren 1. Ordnung wie beim Hund auf 200-300 an, so ergäbe dies für jede Niere 200,000-300,000 Harnkanälchen." The number of tubules arising from a duct of the first order, 1024, was incorrectly quoted by Policard ('08) as Peter's estimate for the whole kidney.

Miller and Carlton in 1895 made an enumeration of the glomeruli in the cat kidney, based on a previous determination of the average volume of the cortex. They cut sections in series at a thickness of 0.10 mm. of a kidney injected with Prussian-blue gelatin. The outline of the section traced on paper and measured with a planimeter gave the area. They found that 50 per cent to 83 per cent of the glomeruli represented the actual number, the rest representing duplicate counts of glomeruli appearing in more than one section. They computed the content of an average volume kidney of 12.9 cc. containing 9.03 cc. of cortex in one estimation as from 9,183.49 to 15,325.13 glomeruli. Another estimation gave them from 13,288 to 22,220 glomeruli. The mean of these estimates is 15,664.

Brodie ('14) in 1914, with the assistance of Miss M. G. Thackrah, estimated the glomerular content in two dog kidneys, using a method similar to Miller and Carlton's. Brodie and Thackrah, however, cut a complete series of sections, 8 μ thick, of previously weighed pieces of cortex. In these sections the total number of glomeruli was counted and divided by the number of sections in which on the average a single glomerulus would

appear. In this way a ratio of number of glomeruli to weight was obtained from which the whole content of the cortex could easily be computed. The first dog weighed 11 kgrm., its right kidney weighed 34.5 grams, and the total number of glomeruli was 142,000. A kidney of a second dog, weighing a little over 8 kgrm., contained 125,000 glomeruli.

It is difficult to find a basis for comparison of these results because in the case of the cat only have we estimates made by two investigators. In this case the estimate of Peters is more than tenfold that of Miller and Carlton. The method employed by Miller and Carlton, however, involved the actual count of the glomeruli in series, and thus is less open to objection than that of Peters, who used in his computation a factor obtained from study of the dog's kidney.

If we compare in so far as is practicable the results of Miller and Carlton on the cat with those of Brodie on the dog, we find that Brodie's result, though agreeing fairly well with the estimate of Schweigger-Seidel on the pig, involves a content per milligram of kidney approximately three times as great as that of Miller and Carlton. The recent work of Bremer ('16) on the activity of the mesonephros in the embryos of various mammals, as indicated by the number and size of the glomeruli and by the increase in number and size of them in progressive phases of embryonic development, may throw some light on the variations in glomerular content of the kidneys of different species of mammals. Bremer found "that the different embryos can be classed as those which retain a functional wolffian body until the kidney is ready to take up the work of excretion, and those in which the wolffian body disappears early, before the kidney has developed active glomeruli." He finds also in the placenta of the latter group evidences of anatomical specialization for interchange with the maternal circulation, which justify the assumption of an excretory function on the part of the placenta. Thus it appears probable that the development of the kidney may be influenced by the concurrent existence, functional capacity, and history of other excretory mechanisms. Bremer also points out that within each of the classes which he recog-

nizes, "individual animals are provided with a very varying amount of excreting surface, showing presumably varying types of metabolism." The discussion of these interesting correlations must, however, be postponed, pending a confirmation by newer and better methods of the counts of glomeruli made in other mammals, which must in addition be supplemented by a careful quantitative study of the relative total glomerular surfaces—a study which involves a consideration not only of the number, but also of the size and lobulation of glomeruli.

My determinations have been made by a method essentially similar to that employed by Schweigger-Seidel, except that in most cases I counted the glomeruli in a much larger percentage of the cortex and, in two cases counted the glomeruli in the entire cortex of an adult rabbit's kidney. In addition, the glomeruli were stained so that there was no difficulty in seeing them and distinguishing them from tubules, which might be difficult in the unstained kidney used by Schweigger-Seidel.

The method is essentially the same as that employed by Bensley in the enumeration of the islands of Langerhans in the pancreas. Janus green B when injected by way of the blood vessels in the living kidney, has the property of staining the glomerular tufts intensely, and the stain can be easily fixed permanently by means of ammonium molybdate (Merck or Kahlbaum). According to Cowdry ('18), janus blue has the same property, but we have not employed this dye.

The animal is killed by bleeding from the carotid, the chest rapidly opened and a cannula inserted in the arch of the aorta. Through this 0.85 per cent salt solution is injected until the blood is well washed out of the kidney, when it is followed by a 1 in. 10,000 solution of janus green in salt solution. When the kidney is a uniform blue color, it is covered up by the intestines for fifteen to thirty minutes, to permit reduction of the excess dye. When this process is complete the kidney presents a purplish tint on its surface. Then a 5 per cent solution of ammonium molybdate is injected to check further reduction, and the kidney is removed and placed in a jar containing molybdate. In a successful preparation only the glomeruli will be deeply

stained blue, and as Cowdry (*loc. cit.*) remarked, they can be seen and counted even in thick pieces.

For counting it is necessary to separate the cortex from the medulla, except where a total count is to be made. This involves no great difficulty, since the cortex is deeply stained blue from the numerous glomeruli contained in it. To accomplish this, the kidney is cut into ten or twelve thick slices, out of which the medulla is carefully cut with a scalpel. When this is done a certain amount of fluid escapes, so it is important to determine at the same phase of the work the ratio of weight of sample counted to whole cortex. I have found also that pieces left in ammonium molybdate for some time change considerably in weight. As soon as the cortex is separated from the medulla the total weight is obtained, and a piece selected for counting and immediately weighed.

For counting, the method of teasing and compression is employed. The block to be counted is divided into small fragments which are teased apart and then compressed between two slides, or under a thick cover-glass. Counting is not difficult, and I am confident that the errors of counting are few. Doubtless some error is introduced by incomplete staining and by irregular oedema of the parts of the kidney. Another source of error is incomplete separation of medulla from cortex. As a check on the method of estimation, ten estimates and a complete count were made on the left kidney of a female rabbit weighing 1470 grams. The kidney contained by actual count 227,263 glomeruli. The average of the estimates was 212,269—an error of 6.7 per cent; but the error of the individual estimates varied from 19 per cent plus to 27.7 per cent minus. However, the error of six of the ten estimates was less than 9 per cent and of four less than 4 per cent. A plus error may arise through selecting for counting a piece from the surface of the cortex where the ratio of *pars convoluta* to *pars radiata* is high, and conversely a minus error may arise, as the table shows clearly, from incomplete separation of the medulla from cortex. By care in selection of the sample to be counted, the error may be reduced to less than 10 per cent. The results are contained in the subjoined tables.

The results of these counts and estimates are unexpectedly high. The actual content of glomeruli in a rabbit's kidney is tenfold that admitted for the kidney of the cat by Miller and Carlton, and more than one-third of the content found by Schweigger-Seidel in a pig's kidney fifteen times as heavy. Such differences, if true, suggest interesting physiological and anatomical implications, into the discussion of which, however, we cannot enter at present, pending the confirmation by newer and more accurate methods, of the results obtained by other investigators. This work is now in progress.

TABLE 1

NO.	SEX	BODY WEIGHT	KIDNEY WEIGHT ¹	CORTEX WEIGHT	WEIGHT OF SAMPLE	GLOMERULI	TOTAL
			gm.				
1	M	1990	Total count of one kidney				163075
2	M	1665	R 6.09	3.69	0.21	9221	161991
			L 6.56	3.73	0.19	8171	160390
3	F	2145	R 8.40	5.38	0.36	10460	156020
			L 8.68	5.54	0.42	11733	154566
4	M	2040	R 8.22	5.4	0.33	10326	168966
			L 8.27	5.6	0.175	3704	118160
5	M	2000	R 8.51	5.1	0.165	5405	166770
			L 8.24	4.6	0.290	10387	164680

¹ The weights of the kidney given in this table have no value except in relation to the counts, because different kidneys acquire different degrees of oedema in the process of staining.

TABLE 2

Female rabbit, weight 1470 grams

		Glomeruli
Total weight of kidney	9.98 grams.....	227,263
Total weight of cortex	4.85 grams.....	223,150
Total weight of medulla	5.13 grams.....	4,113
(plus cortex in separation)		

TABLE 2—Continued
Estimations

NUMBER	WEIGHT	MEDULLA PLUS OR MINUS	COUNT	ESTIMATE	PER CENT OF ERROR
1	0.160	Not observed	7,175	217,488	4.3 minus
2	0.140	Minus	7,843	270,846	19.1 plus
3	0.250	Plus	10,668	206,959	9.3 minus
4	0.280	Plus	9,482	164,228	27.7 minus
5	0.220	Minus	10,597	233,557	2.7 plus
6	0.250	Minus	11,868	230,439	1.3 plus
7	0.250	Minus	11,700	226,980	0.1 minus
8	0.290	Plus	12,395	207,244	8.8 minus
9	0.270	Plus	9,633	173,008	23.8 minus
10	0.230	Plus	9,081	191,427	15.7 minus
Average of the estimates				212,269	6.7 minus

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Resumen por la autora, Mary T. Harman.

Sobre el origen del notocordio en el pollo.

Dos pollos anormales producidos en nuestro laboratorio presentaban notocordios excepcionales. Ambos fueron incubados durante tres días. Uno de ellos fué incubado a una temperatura de 106°F. y el otro a una temperatura de 99° a 100°F. En el primer pollo el notocordio es bifurcado en su extremo anterior, en próximamente un tercio de su longitud. En esta misma región el tubo neural está también bifurcado ventralmente. El intestino no presenta indicio alguno de bifurcación. En el segundo pollo el notocordio en el extremo posterior no solo está en contacto con el tubo neural, sino que se continúa con él. El endodermo del saco vitelino está por completo separado del notocordio. Las condiciones excepcionales descritas constituyen pruebas en favor de la teoría del origen ectodérmico del notocordio.

Translation by José F. Nonides
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CONCERNING THE ORIGIN OF THE NOTOCHORD IN THE CHICK¹

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ONE PLATE (FIVE FIGURES)

The presence of the chorda dorsalis or notochord sometime during the life-history is one of the characteristics which distinguishes the Chordata from the other phyla of the animal kingdom. As to its origin, few other embryonic structures have received more attention from investigators, and yet there exists the greatest diversity of opinion concerning its early embryonic development. All three germ layers have been given as its origin. As early as 1881 Hatschek described the notochord as being folded off from the primitive gut. This is the view held by Hertwig ('05), McMurrich ('15), and others. Prentiss and Arey ('17) say that "the head (notochordal) process and mesoderm of higher vertebrates are not clearly of entodermal origin, but are derived from the ectoderm, any union with the entoderm being secondary." Huber ('18) also considers the notochord to be of ectodermal origin, which becomes associated with the entoderm, and then afterward separated from it. King ('03) says that in *Bufo lentiginosus* the anterior part of the notochord is entirely mesodermal in origin, and that in the posterior part it is mostly derived from mesoderm, but that there is added to it a layer of entoderm from the archenteron.

These differences of opinion are not entirely due to the fact that the investigators have been working with different vertebrates, for Foster and Balfour ('83) say that in the chick the notochord in most instances arises from the anterior end of the

¹ Contribution from the Zoological Laboratory, Kansas State Agricultural College, no. 57.

primitive streak and remains attached to the 'hypoblast' (entoderm), but in other cases the notochord appears to become differentiated in the already separated layer of mesoderm. Prentiss and Arey ('17) say that the notochordal plate in birds is mesodermal in origin and later becomes fused with the entoderm. However, they state that the mesodermal plate which goes to form the notochord arises from the thickened ectoderm of the primitive streak.

These great differences of the opinions of able investigators have led the writer to record some abnormal conditions in the notochord of some teratological specimens of the chick produced in our laboratory (Harman, '18; Alsop, '19). It is not the purpose of the writer to give an extended discussion of the vast amount of literature on the origin of the notochord which must of necessity include the origin of the germ layers, but rather to present the conditions as found in these specimens and discuss to some extent the possible bearing upon the theories of the origin of the notochord.

The illustrations are taken from two of the specimens referred to above. Both chicks were incubated for three days. One was incubated at a temperature of about 106°F., and in addition to a very abnormal central nervous system has a bifurcate notochord. The double condition is in the anterior end and extends caudad to the region of the origin of the vitelline veins. Transverse sections of this specimen are represented in figures 1, 2, and 3. The other chick was incubated at a temperature of between 99°F. and 100°F. The abnormal condition of the notochord is shown in figures 4 and 5.

Figure 1 is a section through the chick about 50 μ from the extreme anterior end of the notochord. The notochord, marked *nc* in the figure, is rather small, cylindrical in shape, and instead of being in a median line ventral to the hind-brain, marked *nt* in the drawing, it is in two parts or cylinders located a little to either side of the midventral line. The hind-brain in this region encloses two cavities, a larger dorsal cavity and a very small ventral one. The small cavity is slightly forked ventrally. The respective horns are in a direct line with the noto-

chord of that side. The pharynx, marked *g* in this section, has no indication of the double condition dorsally.

The notochord is double for a distance of about $1\frac{1}{4}$ mm. or through the heart region, a distance of about one-third of its entire length. Figure 3 is a drawing of a section at the point of the convergence of the two horns of the notochord. Figure 2 is a drawing of a section about midway between the sections represented in figures 1 and 3. It will be noted that in figure 3 the notochord is large compared with the double notochord represented in the other two figures. It also has a slight indication of its double condition. The neural tube here also is somewhat double ventrally. Posterior to this region, both the notochord and neural tube are single and appear to be normal for this stage of development. Anterior to this region, the two parts of the notochord gradually diverge and the respective horns become smaller to the region represented in figure 2. Then they come a little closer together, but remain about the same size, as is shown in figure 1. The two cavities of the central nervous system are found only in three sections, but the bifurcate condition of the ventral side of the central nervous system is very distinct in the entire region of the double notochord.

Figures 4 and 5 are drawings of sections through the posterior third of a three-day chick incubated at a temperature between 99°F. and 100°F. The section represented by figure 4 is about $\frac{1}{3}$ mm. anterior to the other one. The neural tube in this region is not quite normal, but its abnormality is more striking a few sections anterior where they are two and three central canals as previously described (Harman, '18; Alsop, '19). As shown in figure 4, the notochord seems to be directly continuous with the neural tube, although the two are almost separated. The entoderm, *en*, of the yolk sac lies close to but entirely separated from the notochord. Posteriorly, as shown in figure 5, the continuity of the notochord with the neural tube is more conspicuous. In fact, the constriction between the notochord and the neural tube is not very deep, and an examination of the cells with the high power of the microscope shows that they are of the same character in both of the structures. The entoderm of the yolk sac is in contact with the notochord, but is distinct from it.

In the case of the first chick, two hypotheses may be considered: either the notochord became bifurcate at the time of its formation or after it was formed. If the former, the factor or factors which by their influence caused the doubling would have affected the structure from which the notochord originated and we should expect an indication, at least, of a double condition of this structure; if the latter, we must suppose the doubling to be accompanied by a growth in its diameter, since each of the paired notochords is of nearly normal size. It is well known that increase in diameter is not normally noticeable in the chick notochord, as the chief difference between that of a one-day chick and that of a three-day chick is in its length. It is evident that increase in length could not produce bifurcation. Therefore, it is hardly probable that bifurcation occurred after the notochord was formed, and we can return to the assumption that the notochord became bifurcate at the time of its formation.

Surrounding the notochord is mesoderm, ventral to it is the gut which is entodermal in origin, and dorsal to it is the neural tube which is ectodermal in origin. If the notochord came from the surrounding mesoderm, it probably developed in situ, since there is no indication of a doubling of the mesodermal structures. The writer sees no condition in favor of this hypothesis and on the other hand no direct evidence against it. If it has arisen in situ it is unique among compact structures of embryonic development which usually arise from a region of unequal proliferation of cells which finally results in a folding or in the formation of a thickened plate. Since there is no evidence of an unequal proliferation of mesodermal cells, the indirect evidence is rather against the theory of the mesodermal origin of the notochord.

If we assume that the notochord is entodermal in origin, we will have to accept that it came from the gut or from the yolk sac before the gut was formed, for these are the only structures of this region of entodermal origin. There is no indication of a doubling of the gut; therefore, from our hypothesis the notochord cannot be entodermal in origin. Then it must be ectodermal, since, as we have shown, it is hardly probable that it is either mesodermal or endodermal. Let us examine the evidence for the hypothesis of its ectodermal origin.

If it were ectodermal in origin, it must have come from the ventral surface of the neural tube. As we have shown previously, the neural tube in the region of the double notochord is double ventrally and where it is single the neural tube is also single. Furthermore, in a normal chick the notochord lies ventral to the median line of the neural tube and the single *canalis centralis* is in direct line with the notochord. In this specimen the *canalis centralis* is forked ventrally. If the respective forks of the *canalis centralis* should be considered as being in the ventral portion of a complete neural tube, then the notochord of the respective sides would have a normal position with reference to the neural tube.

It would seem, then, either that some factor or factors affected the notochord and the neural tube, at the same time causing both of them to bifurcate at least partially, or that they caused the formation of two neural grooves instead of one and that the notochord arose from the ventral surface of the neural tube. This seems all the more probable since both structures are double in the same place and since they are the only structures of this region showing this condition. Therefore, the facts indicate that the notochord became forked at the time it was formed and that it came from the ectoderm.

The condition in the second chick gives added evidence that the notochord has arisen from the ventral part of the neural tube or at least from the ectoderm from which the neural tube is formed. As was given above in figure 4, the neural tube is continuous with the notochord, while in figure 5 not only are they continuous, but it is impossible to tell where neural tube stops and notochord begins. Moreover, the entoderm of the yolk sac is completely separated from the notochord. It seems, then, that the notochord is ectodermal in origin.

To summarize, then, the bifurcate condition of the notochord and a similar condition in the ventral portion of the neural tube in the case of the first described, together with the absence of evidence of a double condition in any other structure in this region, is evidence in favor of the theory that the notochord in the chick is ectodermal in origin. In the case of the second chick, the continuity of the cells of the neural tube with those of the

notochord as well as the complete separation of the entoderm of the yolk sac from the notochord is added evidence for the theory of the ectodermal origin of the notochord.

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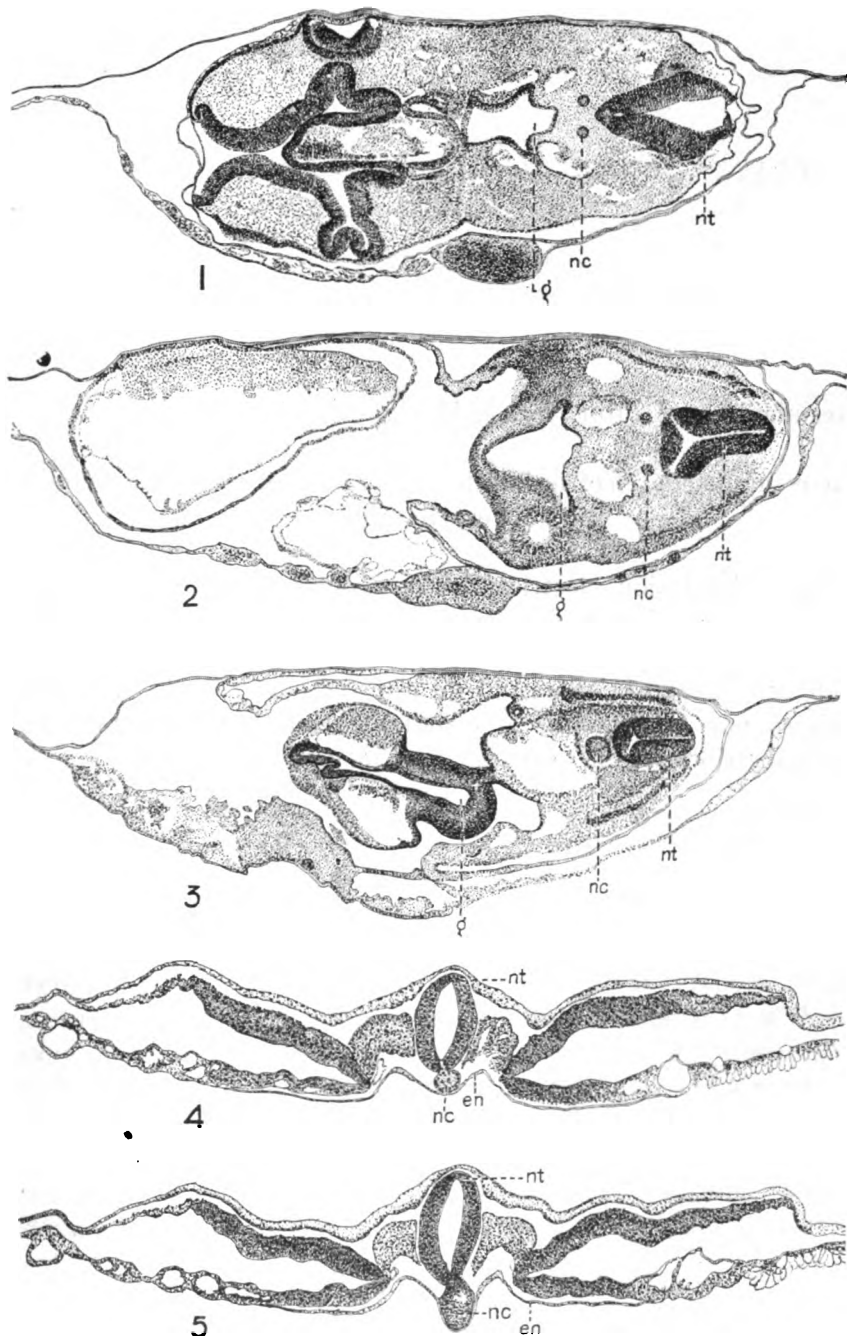
PLATE 1

EXPLANATION OF FIGURES

All figures were enlarged about 135 diameters and then reduced one-half.

Figures 1, 2, and 3 are sections through a three-day chick incubated at 106° F. Figures 4 and 5 are sections through a three-day chick incubated at 99° F. to 100° F.

- 1 Section through the anterior portion of the notochord. *nc*, notochord; *g*, gut; *nt*, neural tube.
- 2 Section through the middle of the heart. *nc*, notochord; *g*, gut; *nt*, neural tube.
- 3 Section through the origin of the vitelline veins. *nc*, notochord; *g*, gut; *nt*, neural tube.
- 4 Section through the chick about one-third of its length from the posterior end. *nt*, neural tube; *nc*, notochord, *en*, entoderm of yolk sac.
- 5 Section through the chick about $\frac{1}{4}$ mm. posterior to the section represented in figure 4.



Resumen por el autor, Walter Hughson.

La estimulación eléctrica de los nervios cutáneos. Un método de enseñanza.

La estimulación eléctrica de los troncos nerviosos cutáneos ha sido empleada por el autor como un método de enseñanza de los estudiantes de Anatomía macroscópica. Trotter y Davies han demostrado la exactitud de este método y su uso ha sido valioso por suministrar al estudiante conocimientos prácticos de la distribución final y variaciones de estos nervios.

Translation by José F. Nonides
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ELECTRICAL STIMULATION OF CUTANEOUS NERVES: A TEACHING METHOD

WALTER HUGHSON

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TWO FIGURES

The usual method of teaching the distribution of cutaneous nerves to students in gross anatomy must be regarded in a general way as unsatisfactory. Careful dissections of individual nerve trunks do little more than indicate roughly the region supplied, while text-books with their variegated illustrations leave in the mind of the student a confused idea of some association between cutaneous sensibility and one or more of the different colors used. Such an interesting and important detail as variation in the ultimate distribution of a given nerve is almost impossible of demonstration with our present methods. In short, the student's whole conception is so vague that after having completed his course in anatomy he promptly loses any detailed knowledge he may have gained by his study of text-books and dissections.

Trotter and Davies,¹ in their work on the innervation of the skin, attempted to establish definite anatomic relations for several cutaneous nerves. Variations in the course of the nerves were so great, however, that this was found impossible. Exposure of the nerve trunk for section which formed part of their experiment often involved a skin incision out of all proportion to the size of the procedure. They therefore devised a method of localization which consisted simply of stimulating the nerve-trunk through the skin with a weak faradic current by a finely pointed unipolar electrode. The sensation of tingling corresponded exactly to the peripheral distribution of the nerve.

¹ Trotter, W., and Davies, H. M., *Jour. of Phys.*, 1909, vol. 38, p. 134.

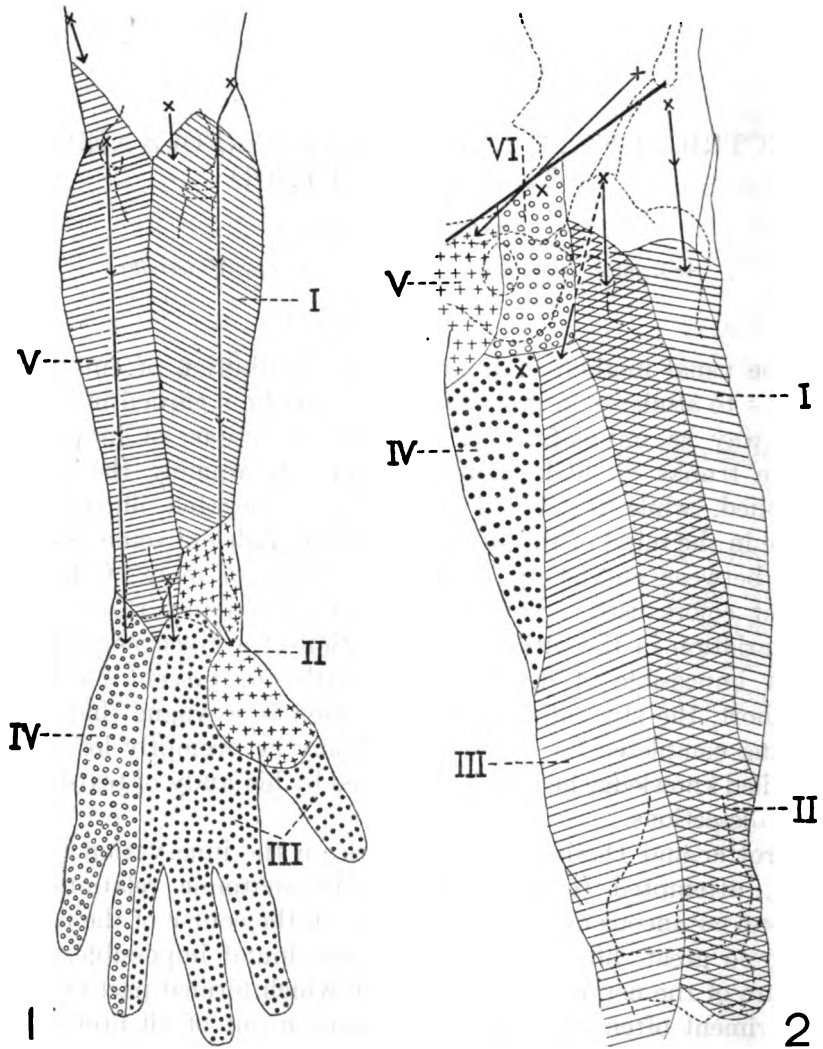


Fig. 1 Volar surface left forearm. *I*, Lateral antibrachial cutaneous; *II*, cutaneous distribution of radial; *III*, of median, and *IV*, of ulnar; *V*, median antibrachial cutaneous.

Fig. 2 Anterior aspect of left thigh. *I*, Lateral femoral cutaneous; *II*, intermediate; and *III*, medial cutaneous branches of femoral; *IV*, cutaneous branch of obturator; *V*, of ilio-inguinal, and *VI*, of genito-femoral.

Application of the stigmatic electrode a millimeter or more to either side of the nerve-trunk failed to elicit any sensation; the accuracy of the method was further demonstrated at operation by finding the nerve immediately beneath the point of localization on the skin. After section, the area of anesthesia corresponded exactly to the distribution determined by stimulation.

The method was used in an elective course in applied anatomy to show the distribution of the cutaneous nerves throughout practically the entire body. A small induction coil (Harvard Instrument Company) was used with a single dry cell. A current considerably weaker than that necessary to cause muscular contraction was found to be sufficient to stimulate the sensory nerves. The indifferent electrode was placed at any convenient point on the body and the stimulating electrode applied to the skin to locate the nerve trunk as it emerged from the deep fascia. The general position of the nerve had previously been determined by the student by dissection. The distinctness of the response to stimulation proved to be very striking and the areas could be mapped out after a small amount of practice with great accuracy.

Figures 1 and 2 represent the type of diagram which the individual student can make. The entire procedure can be carried on without assistance. The nerve is first picked up at the point where it pierces the fascia and can then be followed in all its branches. In the figures, X marks the point of stimulation and the arrow the area of distribution indicated by shading. In figure 1 the arrow shows that stimulation of the radial and ulnar cutaneous nerves along their entire course from the elbow will give the typical sensory distribution. The cutaneous branches of the median nerve, however, can be stimulated on the volar surface of the forearm only at the wrist. The lateral and medial cutaneous nerves of the forearm can best be stimulated above the elbow. Figure 2 represents a fairly typical diagram of the cutaneous innervation of the front of the thigh. The intermediate branch of the femoral becomes superficial higher up than the medial branch, as is indicated by dotted lines, but the whole distribution is clearly shown. The cutaneous

branch of the obturator is surprisingly accessible. Of some interest is the fact that in this individual the obturator of the opposite side had an area of distribution considerably below the knee. The ilio-inguinal can be found very readily above the inguinal ligament. The whole body with the possible exception of the intercostal nerves can be charted in exactly the same manner. Stimulation of the cutaneous branches of the trigeminal, the branches of the cervical plexus, etc., all give the sharp outline indicated in the figures.

This method then gives the student an actual physiological proof of the distribution of his own cutaneous nerves and fixes this distribution firmly in his mind as dissections and pictures can never do. By comparison with other charts he learns that there is a great variation between different individuals and even between opposite sides of the same individual. And finally the simplicity of the apparatus and method makes it entirely practical for use in large classes.

Resumen por el autor, I. M. Thompson.

Anomalía del nervio medio y del músculo flexor sublime de los dedos.

El autor describe una anomalía del nervio medio del antebrazo, el cual estaba enterrado en el vientre radial del flexor sublime de los dedos, en la mayor parte de su curso en el antebrazo. Dicho músculo era también anormal, presentando separados los orígenes radial y húmero-ulnar, y este último estaba subdividido de nuevo inmediatamente debajo del codo en un vientre lateral pequeño y un vientre medio grande. La disposición de los tendones de este músculo en la muñeca era también excepcional. El autor presenta una explicación embriológica de la anomalía descrita, indicando también su importancia práctica.

Translation by José F. Nonidez
Cornell Medical College, New York

ANOMALY OF MEDIAN NERVE AND FLEXOR DIGITORUM SUBLIMIS MUSCLE

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ONE FIGURE

The following anomaly was observed in the dissecting-room at McGill University during the session of 1921-22. As I have not succeeded in finding a description of the condition in the usual records, it would appear to be uncommon, and its importance from a practical point of view makes it the more worthy of being recorded.

The subject was a female, aged eighty-six, with attenuated musculature. The median nerve of the right-arm descended into the forearm between the two heads of the pronator teres in the usual manner. Then it passed deep to the radial origin of the flexor digitorum sublimis, the latter consisting of a slender belly which was not united to the humero-ulnar origin. About 35 mm. distal to this point (i.e., about 130 mm. distal to the medial epicondyle of the humerus) the nerve sank into the substance of the radial belly, and remained completely embedded therein down to a point about 25 mm. above the wrist-joint. Here the tendon of this belly divided into two, a medial and a lateral; and the nerve appeared between them, lying anterior to the lateral tendon and between the medial tendon and that of the flexor carpi radialis. The subsequent course and distribution of the nerve presented no unusual feature.

The following associated conditions may be mentioned. As indicated, the flexor digitorum sublimis was abnormal. In the first place, the radial and humero-ulnar origins remained entirely separate. Just below the elbow the humero-ulnar origin divided into a large medial belly and a smaller lateral belly.

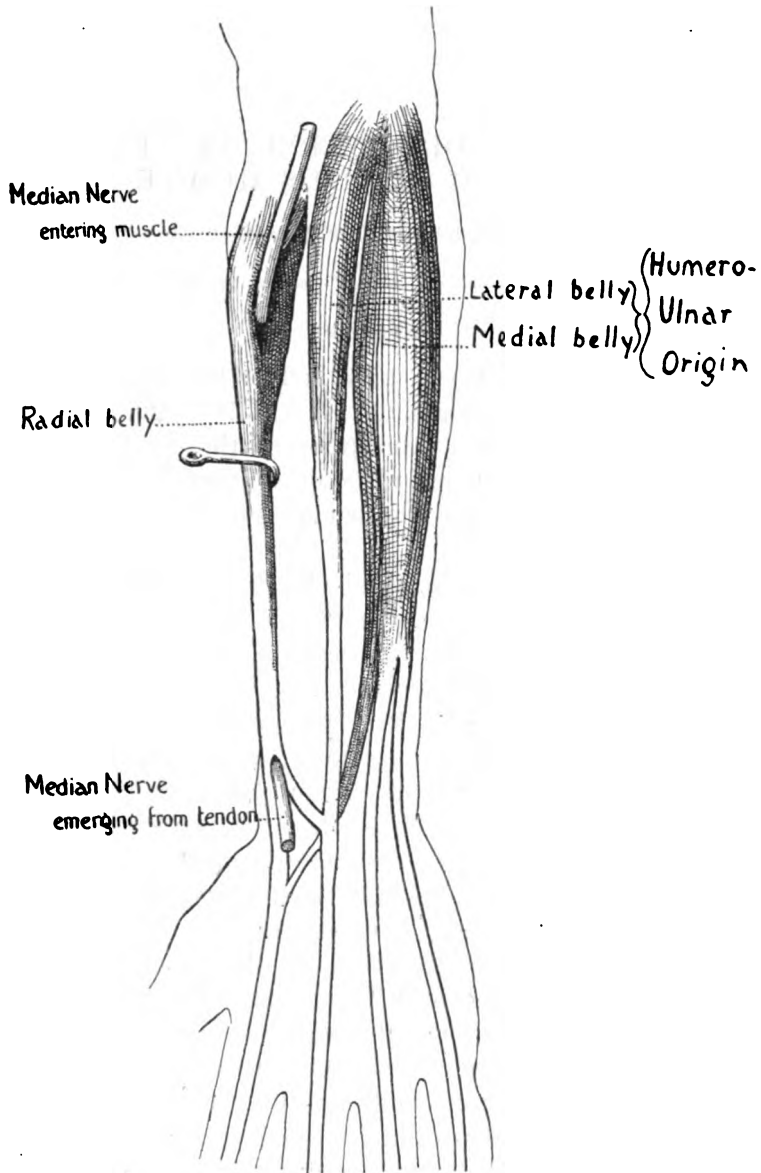


Fig. 1 Right forearm and hand, volar aspect, showing anomalous median nerve and flexor digitorum sublimis muscle. The upper part of the radial belly has been retracted laterally and twisted, exposing its deep or dorsal aspect, with the median nerve entering the muscle. For further description see text.

About 60 mm. above the wrist-joint the medial belly was continued into two tendons, a medial and a lateral, with the addition of a small fleshy lateral slip. The smaller medial tendon went to the little finger, whilst the larger lateral tendon terminated in the ring-finger. About the middle of the forearm the lateral humero-ulnar belly was continued into a tendon which went to the middle finger, being joined at the level of the wrist-joint by the medial tendon of the radial belly.

The slender separate radial belly, in which the median nerve was embedded, arose by fleshy fibers from the lower end of the oblique line of the radius. About the middle of the forearm it gave rise to two tendons, a medial and a lateral, which were closely bound together (enclosing between them the median nerve) down to a point about 25 mm. above the wrist-joint, where they separated. The medial tendon joined the tendon of the lateral humero-ulnar belly to form the tendon of the middle finger. The lateral tendon went to the index finger, being joined about 20 mm. below the wrist-joint by the tendon of the small fleshy slip noted above as arising from the lower end of the lateral aspect of the medial humero-ulnar belly, this fleshy slip having become tendinous where it crossed deep to the tendon of the middle finger, at the level of the wrist-joint. The ultimate insertions of these tendons in the fingers presented no unusual feature.

The palmaris longus was absent on both sides.

On the right side the ulnar artery arose as a collateral branch of the brachial artery opposite the upper end of the insertion of the coracobrachialis. It was small, and passed superficial to the common flexor group of muscles. The radial artery was the direct continuation of the brachial artery, was larger than usual, and gave off the common interosseous artery.

On the left side there were no anomalies except the absence of the palmaris longus.

Normally, the median nerve is closely adherent to the deep surface of the flexor digitorum sublimis, to which it is bound by relatively dense connective tissue. This fact is not stated in the majority of the text-books of anatomy, but is easily

verified by dissection. The present anomaly appears to be a further stage of this normal condition, the nerve not merely adhering to the deep surface of the muscle, but actually being embedded within its substance.

W. H. Lewis (The development of the arm in man; *Am. Jour. Anat.*, vol. 1, 1902, p. 145) describes the median nerve in a human embryo of 9 mm. as extending to the distal end of the humerus, while the distal part of the arm is filled with primitive mesenchymal tissue which later differentiates into muscle and intermuscular tissue.

In an embryo of 10.5 mm. the same investigator describes the flexor muscle mass of the forearm as consisting of a superficial layer and a deep layer, separable with considerable difficulty, the median nerve lying between them.

In the 9-mm. embryo the median nerve has reached the distal end of the humerus, while the premuscle tissue of the upper arm shows no sign of differentiation. Assuming that what occurs in the arm occurs also in the forearm, we may therefore conclude that between these two stages described by Lewis the median nerve grows down into the undifferentiated mesenchyma of the forearm, which thereafter develops two planes of histogenic demarkation, a superficial plane, anterior to the median nerve, along which the superficial muscle layer is differentiated from the layer of connective tissue which intervenes between the superficial and the deep muscles, and a deep plane, posterior to the median nerve, along which the deep muscle layer is differentiated from the same layer of connective tissue. The median nerve thus comes to lie within the layer of connective tissue, between the two planes of demarkation, but nearer the superficial plane, in which region the connective tissue increases in density, thus binding the nerve to the deep surface of the muscle.

The present anomaly has probably been occasioned by the superficial plane of demarkation passing posterior to the median nerve, which was thus included within the superficial layer of muscle tissue from which the flexor digitorum sublimis was later differentiated.

This anomaly would appear to be of some clinical importance, though no information is available in the present case as to the production of symptoms by such an anatomical condition. In this connection it may be noted that normally certain nerves lie embedded in muscle for a portion of their course, as, for example, the deep branch of the radial nerve, which lies embedded in the supinator.

In those cases which call for operative treatment of the flexor tendons or of the median nerve in the forearm, and in which difficulty is experienced in locating the nerve or its ends, if it has been severed, the possibility of the presence of such an anomaly as that described would appear to be worth bearing in mind.

In the present instance, the nerve, as noted, entered the muscle about 130 mm. distal to the medial epicondyle of the humerus, and emerged from the tendon about 25 mm., or one inch, above the wrist-joint. In the living this would correspond approximately to a point about 25 mm., or one inch, above the proximal skin crease at the wrist.

Resumen por el autor, William H. T. Baillie.

Un caso de ausencia unilateral del riñón, uréter y parte distal del tubo uterino del conejo.

El autor describe una caso, hallado en una coneja, de ausencia del riñón y uréter izquierdos, parte del tubo uterino izquierdo y útero del mismo lado. Teniendo en cuenta las condiciones halladas durante el desarrollo embrionario el origen de la anomalía debe haber tenido lugar próximamente en un periodo entre los 11 a los 15 días del crecimiento embrionario. La relación de este caso con otros publicados es objeto de discusión.

Translation by José F. Nonidez
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CASE OF UNILATERAL ABSENCE OF KIDNEY, URETER AND DISTAL PART OF UTERINE TUBE IN THE RABBIT

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ONE FIGURE

DESCRIPTION

The specimen under consideration is a female with the right side of the urinogenital system normal, save that the right kidney is larger than is usually the case in an animal of the same size. The description of the urinogenital system is as follows:

Left kidney absent; no trace of left ureter; that there was no opening into the bladder on the left side was determined by injecting a semifluid colored mass into the bladder. The right ureter was partially filled.

Left suprarenal body present in normal position, but rotated on its axis through 90° ; supplied with blood from the supracrenolumbar artery.

Left vesicorectal fold present, but contains only the left umbilical artery and does not connect with the vagina.

Right kidney measured 3.4 cm. by 2.2. cm. by 0.7 cm., slightly larger than in normal rabbits of the same occiput-to-tail measurement.

Right ureter normal in position; opening into right side of base of bladder along vesico-uterine fold.

Right suprarenal body normal.

Left ovary slightly longer than right; normal in position. Fimbria, supported by mesovarium, overhangs ovary anteriorly. Oviduct leads to a point near the posterior pole of ovary and ends blindly in a small knob. A narrow mesenterial fold binds oviduct to ovary.

Left ovarian ligament passes from posterior pole of ovary to the point usually reached by left round ligament.

Vagina lies completely to the right. No trace of left uterus.

Left ovarian artery normal in relation. Left ovarian vein passes caudad to join the inferior vena cava just past the point where median sacral artery arises from aorta.

Right portion of genital system normal.

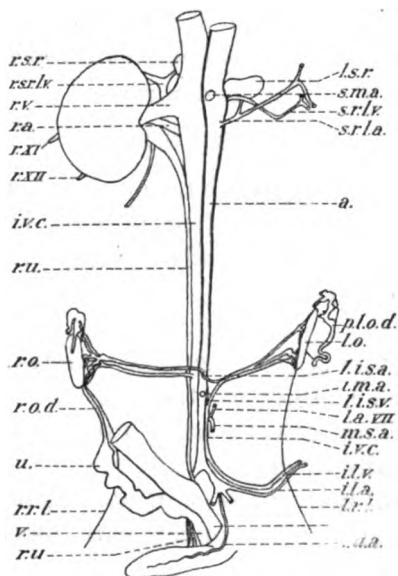


Figure 1. $\times \frac{1}{2}$ natural size

ABBREVIATIONS

<i>a.</i> , aorta	<i>r.a.</i> , renal artery
<i>i.l.a.</i> , iliolumbar artery	<i>r.o.</i> , right ovary
<i>i.l.v.</i> , iliolumbar vein	<i>r.o.d.</i> , right oviduct
<i>i.m.a.</i> , inferior mesenteric artery	<i>r.r.l.</i> , right round ligament
<i>i.v.c.</i> , inferior vena cava	<i>r.s.r.</i> , right suprarenal body
<i>l.a.VII</i> , seventh lumbar artery	<i>r.s.r.l.v.</i> , right suprarenolumbar vein
<i>l.i.s.a.</i> , left ovarian artery	<i>r.u.</i> , right ureter
<i>l.i.s.v.</i> , left ovarian vein	<i>r.v.</i> , renal vein
<i>l.o.</i> , left ovary	<i>r.XI</i> , eleventh rib
<i>l.r.l.</i> , left round ligament	<i>r.XII</i> , twelfth rib
<i>l.s.r.</i> , left suprarenal body	<i>s.m.a.</i> , superior mesenteric artery
<i>l.u.a.</i> , left umbilical artery	<i>s.r.l.a.</i> , suprarenolumbar artery
<i>m.s.a.</i> , median sacral artery	<i>s.r.l.v.</i> , suprarenolumbar vein
<i>p.l.o.d.</i> , proximal part of left oviduct	<i>u.</i> , right uterus
<i>r.</i> , rectum	<i>v.</i> , vagina

PROBABLE ORIGIN OF THE ANOMALY

In studying the condition it occurred to the writer that it might be possible to determine approximately the age of the embryo when the defect arose. The association of the presence of a perfect ovary and a normal proximal part of the uterine tube with absence of the distal part of the same tube and total absence of the kidney and ureter on the same side would give such a clue. The anterior growth of the ureter and the posterior growth of the müllerian duct have both suffered interference.

According to Minot ('05), the ureter first appears at eleven and one-half days in a 6-mm. embryo rabbit, and at fifteen days in a 12- to 13-mm. embryo the müllerian ducts are present, lying on the coelomic side of the wolffian ducts, extending only a short distance and opening into the coelom at the cephalic part of the wolffian body. In man, according to Felix in Keibel and Mall ('12) "At the very time when the posterior end of the groove is separating from the epithelium it begins to grow out caudally and in this process we come to the development of the distal portion of the müllerian duct. It is formed by the gradual outgrowth of the tip of the cornet." Some interference with growth starting near the caudal end of the mesonephric duct before eleven and one-half days and reaching near the anterior end of the mesonephros at about fifteen days must have been responsible for the condition. If this process is in the nature of an extension of the natural degeneration of the mesonephros the latter must have been markedly premature as well as extensive. This is shown by the normal time of onset of the degeneration. Thus Felix and Bühler, in Hertwig's Handbook ('04), put the degeneration in an 18- to 20-mm. embryo at eighteen days. Bremer ('16) states that the placenta takes over the function of the mesonephros at an age corresponding to 21 mm., when the mesonephros begins to degenerate and ultimately loses all active glomeruli at 40 mm. The tubular degeneration is still later. Thus Felix ('04) says, "Beim Kaninchen beginnt die Rückbildung des primären Harnleiters bei 5 cm. langen Embryonen und zwar in der Mitte und schreitet von da rasch in kranialer und kaudaler Richtung vor und führt zum vollständigen

Schwund des primären Harnleiters (Langenbacher, '82)."
The method of degeneration is, however, similar to that which I have visualized in this case.

COMPARISON

Now, if we compare a few cases of a somewhat similar nature, Hunt ('18) describes the absence of the right kidney in a male domestic cat. The right ureter was present, 1.5 cm. long. The genital system and suprarenals were normal. Since the ureter appears in this specimen, the process has not occurred early enough to cause the inhibition of the evagination. The mesonephric duct is also retained normally as the genital duct. Therefore, the destructive agent acted on the nephrogenic mass shortly after the ureter began its growth and did not involve the mesonephric ducts, but only the part of the nephric mass that normally forms the mesonephric and metanephric glomeruli. The next case is described by Lyon ('17) in man. The right kidney, ovary, and uterine tube were absent. The right suprarenal was present, as was also the right ureter, which was connected with the bladder, although no opening from it into the bladder could be found. The interior of the right ureter contained a small amount of granular debris. The uterus was small with only the left tube. This case is one in which another consideration might appear, namely, the division of the mesonephros into a cranial and a caudal part, as shown in Minot's ('10) figures for the pig. The genital gland and the whole duct in Hunt's case and part of the duct in my case were present. In Lyon's case the ovary and the whole tube were missing. These parts are closely associated with the cranial part of the mesonephros. Therefore, my case shows more interference with growth in the region of the caudal mesonephros; Lyon's in the cranial part; while in Hunt's the involvement was caudal, but relatively less. Brown's ('94) case in man shows absence of the right kidney, but the right ureter is present. Harrison ('94) describes in the rabbit an absence of the left kidney and ureter. Both ovaries are present, but uterine tubes and uteri are absent. Here both sides are involved anteriorly. Reterer and Rogers

('93) describe a case in the rabbit with an anomalous condition on the right side similar to the condition described in this paper on the left side (reported by Radasch, '08).

Radasch ('08) gives an extensive review of the literature up to 1908 and concludes that the process causing the loss of kidney is due either to the failure of the ureteric evagination or its retrogression after its appearance. In the case he describes in the cat the presence or absence of the ovary and part of the tube on the right side was not capable of determination, but the right ureter was absent. This would place the condition in a similar class to the one described in this paper.

SUMMARY

A case is described in a rabbit of the absence of the left kidney and ureter, part of the left uterine tube, and the left uterus. By taking into consideration the conditions during embryonic development, the origin of the anomaly is placed at probably from eleven and one-half to fifteen days' embryonic growth. The relationship of this to other reported cases is discussed.

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Resumen por el autor, Warren Lewis.

La cualidad adhesiva de las células.

Es evidente que las células que emigran sobre la superficie inferior del cubreobjetos en los cultivos de tejidos son adhesivas; de otro modo, cuando se emplea un medio de cultivo líquido, caerían al fondo de la gota, puesto que son más pesadas que el medio. Las células son adhesivas a consecuencia del mismo material de que están formadas, del mismo modo que la cola es pegajosa. Sin esta cualidad adhesiva al vidrio y algunos otros sólidos, no podrían emigrar. No existe razón alguna para creer que desarrollan esta cualidad cuando abandonan el trozo cultivado y vienen a ponerse en contacto con el vidrio. Esta cualidad adhesiva varía un tanto, puesto que las células pueden redondearse y desprenderse del cubreobjetos. Este fenómeno es pasivo y no corresponde de modo alguno a la sensibilidad que exhiben ciertos animales para los sólidos, conocida con el nombre de estereotropismo. Las células se adhieren no solo al vidrio y otros sólidos, sino también entre sí en grado variable. Esta cualidad adhesiva juega un papel muy importante en la persistencia del contacto de las células y los diversos tejidos, no solo durante la segmentación y en el embrión antes de formarse las fibras intercelulares, sino también en el adulto. La existencia de continuidad protoplásmica actual, es muy dudosa en la mayor parte de los tejidos, tales como el mesenquima, epitelio y músculo. De tal modo que si las células de nuestro cuerpo perdiesen súbitamente su cualidad adhesiva, nos desintegraríamos repentinamente y los varios tipos celulares formarían una corriente mezclada de ectodermo, músculo, mesenquima, hígado y otros varios tipos celulares.

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THE ADHESIVE QUALITY OF CELLS

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From observations on the behavior of cells in tissue cultures, it seems to me that the causative factors in the phenomena exhibited by the cells in their migration out from the explant along solid supports resolve themselves into two separate categories: 1) a natural stickiness or adhesiveness which these cells appear to have for certain solids and for each other; 2) the forces that cause them to migrate. Concerning the first very little has been written, although I think we have all been aware that many cells are sticky. We have long known, for example, of the adhesive quality of white blood-cells for glass. The importance of this adhesive quality in the various body cells, however, has been almost entirely ignored. Yet most of our tissues and organs are made up of cells that are merely stuck together. Were these various types of cells to lose their stickiness for one another and for the supporting extracellular white fibers, reticuli, etc., our bodies would at once disintegrate and flow off onto the ground in a mixed stream of ectodermal, muscle, mesenchyme, endothelial, liver, pancreatic, and many other types of cells.

It will seem to many that I am overlooking a very important consideration, namely, the so-called syncytial relations supposed to exist in many tissues, such as the smooth muscle, heart muscle, and especially the mesenchyme, as also the ectoderm, by virtue of its so-called intercellular bridges. I am convinced, after the study of the behavior of these cells in tissue cultures of chick embryos, that the outgrowths of these tissues do not form syncytia. From this it would appear highly probable that they do not form syncytia either in embryos of four to ten days' incubation (the usual ages from which the tissues were taken for cultures) or in the adult, and that this holds true not only for birds,

but for mammals as well. Some of the evidence for the non-syncytial nature of mesenchyme has already been published¹ and that for heart muscle, smooth muscle, and ectoderm is nearly ready for publication.

It is almost self-evident that the cells that migrate out on the under surface of the cover-glass, in cultures where a fluid medium is employed, are sticky for glass. They are often apparently quite firmly adherent, and such preparations can be washed and manipulated in various ways and with various fluids, or even fixed and killed by different agents, without disturbing their attachment. They can even be poked with a needle or centrifugalized, and yet the cells will not be dislodged. Of course, cells do frequently become detached from the glass through manipulations of various sorts, or they may at times round up and drop to the bottom of the hanging-drop, but even after rounding up many still remain attached. Not only the bodies, but the cell processes as well possess this adhesive quality, and it not infrequently happens that an outgrowth, contracting back towards the explant, snaps apart some of the more extended processes at the periphery, leaving slender, isolated fragments of cytoplasm adhering to the cover-glass. The adhesiveness of such fine processes, some of them so thin as to be almost invisible, can scarcely be explained on any other ground than stickiness. It is highly improbable that the adhesion is maintained by some sort of suction apparatus. I do not quite see how it could be proved that the cells are or are not sticky for glass before they come into contact with it, and there is no particular reason for believing that they develop such a special adhesive quality as they leave the explant and come in contact with the cover-slip.

Cells are not only sticky for the cover-glass, but for each other as well. In the body of the embryo and in the tissue explant such cells as endothelium, mesothelium, and the endodermal lining of the intestine are undoubtedly merely adherent to their neighbors, but they retain their adhesive quality in the outgrowths and, in addition, stick to the cover-glass. I believe the same thing is true for those cells that have hitherto been supposed to form syncytia.

¹ Lewis, W. H. Is mesenchyme a syncytium? *Anat. Rec.*, vol. 23, 1922.

We may in time be able to measure the force of the adhesions in some way, as by utilizing the centrifugal force necessary to dislodge them, but so far even the high speed of the ordinary centrifuge fails to move those that are flattened out to any extent from their attachment to the cover-glass. The fact that cells do move and shift about, spread out very flat, or round up and drop off indicates that the factors of cohesion and surface tension of the protoplasm are constantly at work in altering the extent and position of the adherent areas, both on the cover-glass and on the other cells. Such changes may very well take place without altering the natural adhesiveness of the surface of the cells, but it is entirely possible that the degree of stickiness also may vary. One wonders whether this sticky quality is dependent upon the composition of the protoplasmic surface membrane that limits all cells or upon some sort of substance that is secreted by the cell as one of the products of its metabolism. The so-called cement, so commonly described as existing between various types of cells, may possibly be an adhesive substance. This is usually recognized by its power to reduce silver nitrate. Now, most living cells in our cultures show a slight browning over their entire surface with silver nitrate, while dead cells do not; it is therefore possible that the silver nitrate is reduced by the living protoplasm and not by any substance on its surface. The heavy lines seen at the contact edges of cells seem to be, in part at least, an optical effect of looking edgewise at a thin granular film.

The important rôle which this adhesive quality plays in the early stages of development, before the formation of extracellular fibrils of any sort, can scarcely be overestimated. Without it multicellular organisms could not exist. When it is repressed, as was done by Herbst ('00)² in the segmentation stages of certain marine animals, by eliminating calcium salts from the sea-water, the blastomeres fall apart and round up and further development of the embryo becomes impossible. In the blastula and gastrula stages the only other factor that might play a rôle in keeping

² Herbst, Curt. Ueber das Auseinandergehen von Furchungs- und Gewebzellen in kalkfreiem Medium. Arch. f. Entw. Mech., Bd. 9, 1900, S. 424.

the cells in position is the pressure from without of an external membrane inclosing the whole organism. I am eliminating entirely the conception of intercellular bridges, which has been postulated by Hensen³ and others, and have adopted the opposite extreme, which may seem to many as far from the truth as the idea of universal cell continuity. In the early embryonic stages, before the formation of extracellular fibrils and other supporting and binding substances, whether these be in the form of gels or of fibers, all the tissues are held together by adhesion or a combination of adhesion and interlacing of elongated and branched cells. In later stages and in the adult the extracellular supporting substances play an important rôle in holding cells and tissues together, but the intercellular adhesions are probably still more important.

The most obvious deduction to draw from the known facts is that the cells in tissue cultures are sticky as regards certain solids, and that this is a natural characteristic. They are sticky because of the very material of which they are composed, just as egg albumen, glue, and mucilage are sticky. If, then, we admit that the cell surface is naturally sticky for glass, we can scarcely consider that adhesion of the cells to solids is a form of tropism. 'Tropism' as the term is usually employed, applies to the phenomenon observed in living organisms of moving toward (positive) or away from (negative) a focus of light, heat, a solid body (stereotropism), or other stimulus. The term 'stereotropism' has frequently been employed to indicate a reaction exhibited by all of the cells in tissue cultures that migrate out from the explants on solid supports. Harrison ('11, '14)⁴ and others have observed that cells that migrate out from the explant always utilize some solid support, such as the cover-glass, fibrin threads, spider-web, fibers of various sorts, or even the surface film of the fluid hanging-drop. None of the ordinary tissue-cells are able to swim about in fluid media. The idea

³ Hensen, V. Ueber die Entwicklung des Gewebes und der Nerven im Schwanze des Froschlarve. *Virchow's Arch.*, Bd. 31, 1864.

⁴ Harrison, R. G. The reaction of embryonic cells to solid structures. *Jour. Exp. Zool.*, vol. 17, 1914. *Science*, vol. 34, 1911.

underlying the use of the term stereotropism, as applied to the cells in tissue cultures, seems to be that there is some sort of positive reaction on the part of the cells toward the solid. Cells migrate only on solids; therefore it is assumed they are in some way attracted by solids. The following quotation from Harrison ('14, p. 541) indicates the present attitude on the subject:

"While it must therefore be admitted that chemical stimuli may play an important part in influencing the movements of cells in simple cultures, as Burrows has pointed out, the facts show that the cells are also stimulated by solids as such and respond to them by an orienting movement. Response to tactile stimuli is of such general occurrence in animals that there is nothing anomalous in the manifestation of the same kind of sensitiveness in cells."

We say that cells are stereotropic because they have only been observed to migrate on solids, and that they migrate on solids because they are stereotropic. To say that cells are stereotropic does not offer any explanation for the fact that they migrate only on solids. On the other hand, the fact that they can only migrate on solids does not necessarily mean that they are stimulated by solids as such, nor is there any reason to believe in a sensitiveness of cells that corresponds in any way to the response of animals to tactile stimuli. The adhesion of cells to solids is a passive phenomenon. Since cells are heavier than the fluid medium, they could not migrate on the under surface of the cover-slip unless they were adherent.

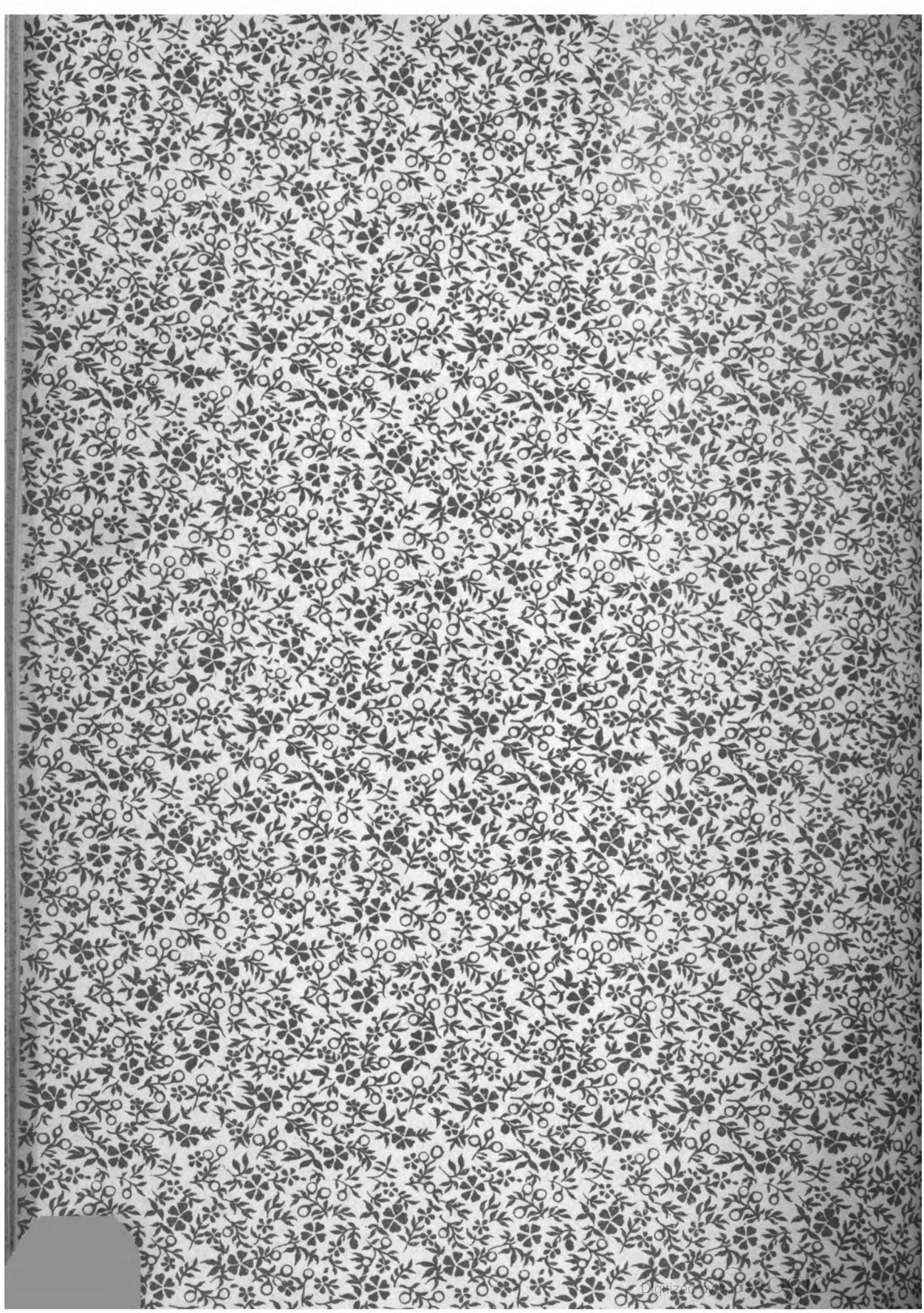
Concerning the factors which cause the cells to migrate out from the explant along the cover-glass or other solids, on the surface film of a liquid drop, or on other cells (which behave as solids), there is still much uncertainty. The work of Tait ('18)⁵ and Leo Loeb ('20)⁶ indicates that the progressive movements

⁵ Tait, J. The capillary phenomena observed in blood cells, etc. *Quart. J. Exp. Physiol.*, vol. 12, 1918.

⁶ Loeb, Leo. The movements of the amoebocytes and the experimental production of amoebocyte (cell-fibrin) tissue. *Wash. Univ. Studies*, vol. 8, Scientific Series no. 1, 1920.

of the cells may depend upon local variations in the metabolism which produce local changes in the fluidity and surface tension of the cells, while the observations of Burrows⁷ suggest that the interchange of substance between explant and medium may offer a basis for a differential localization of metabolism.

⁷ Burrows, M. T. The tissue culture as physiological method. Trans. Cong. Amer. Physicians and Surgeons, vol. 9, 1913.



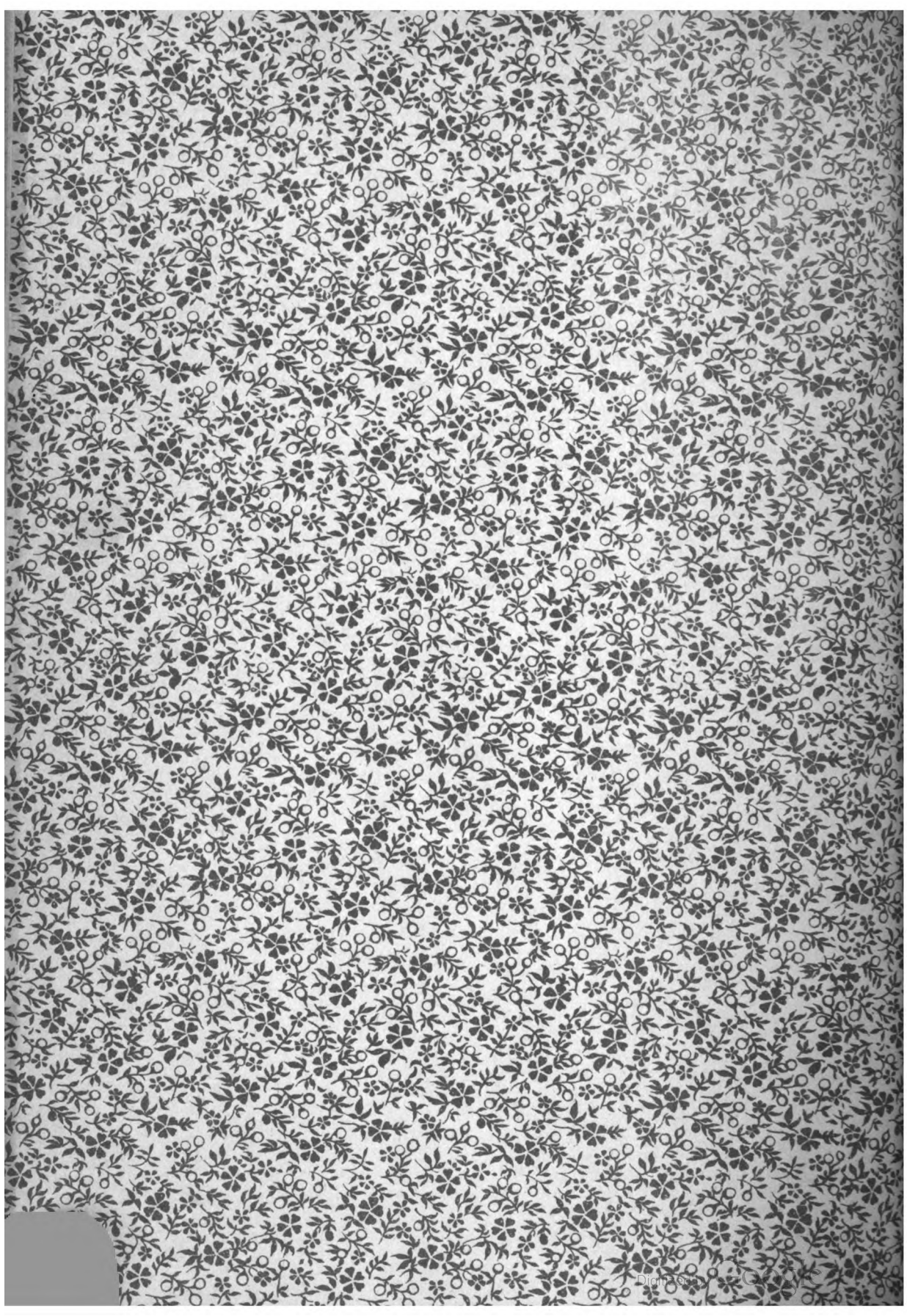


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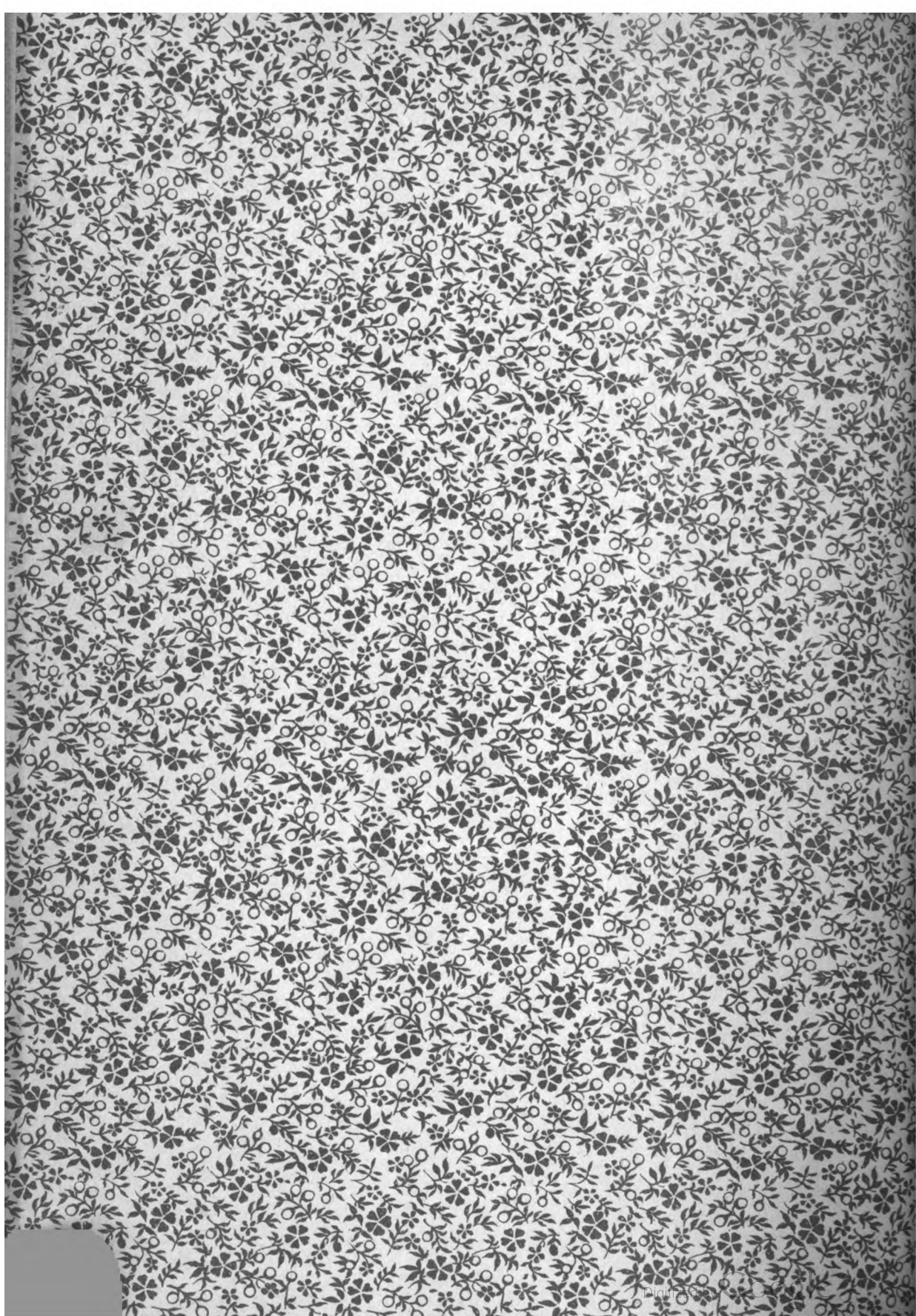


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